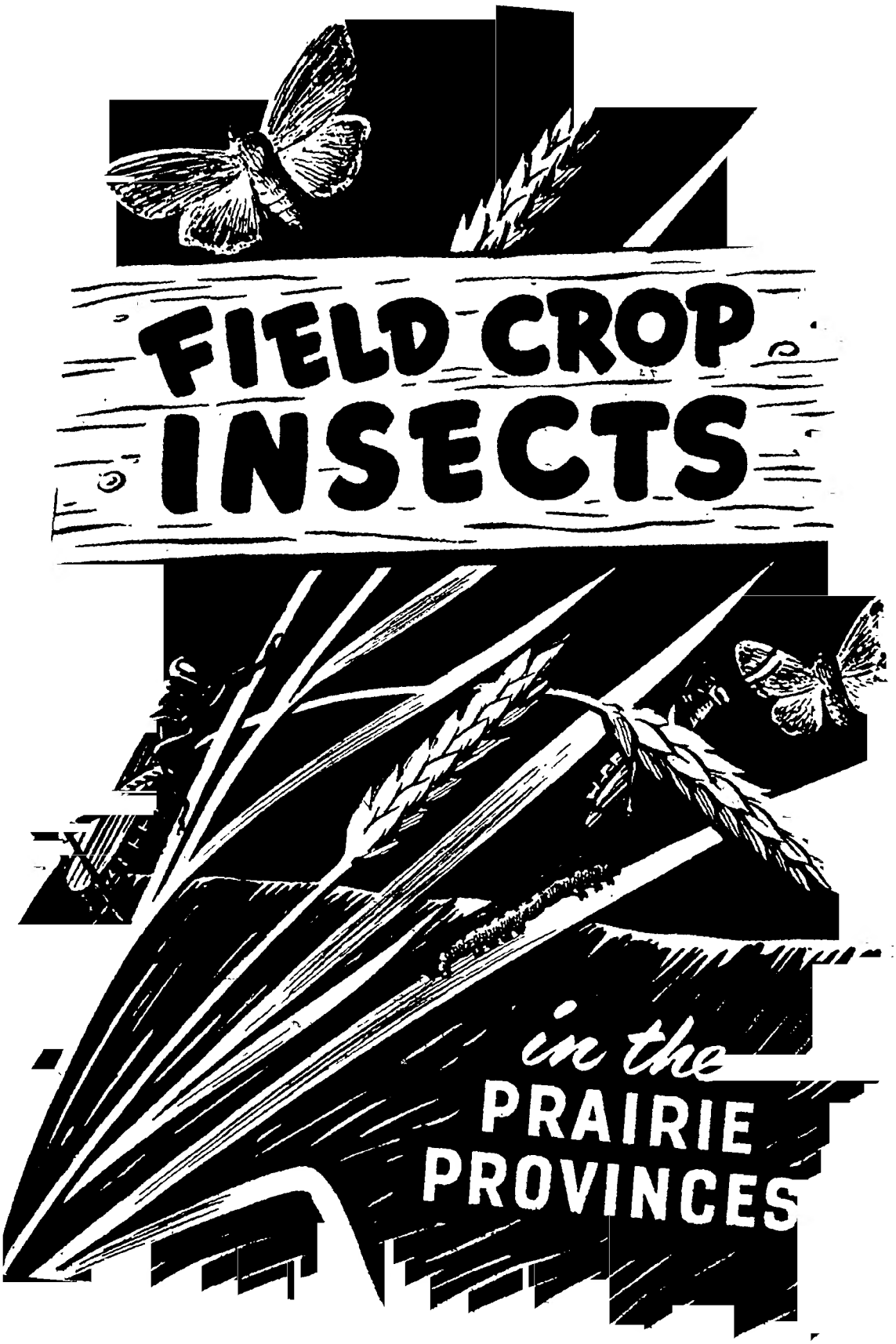
FIELD CROP
INSECTS
in the
PRAIRIE
PROVINCES

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BULLETIN NO. 5

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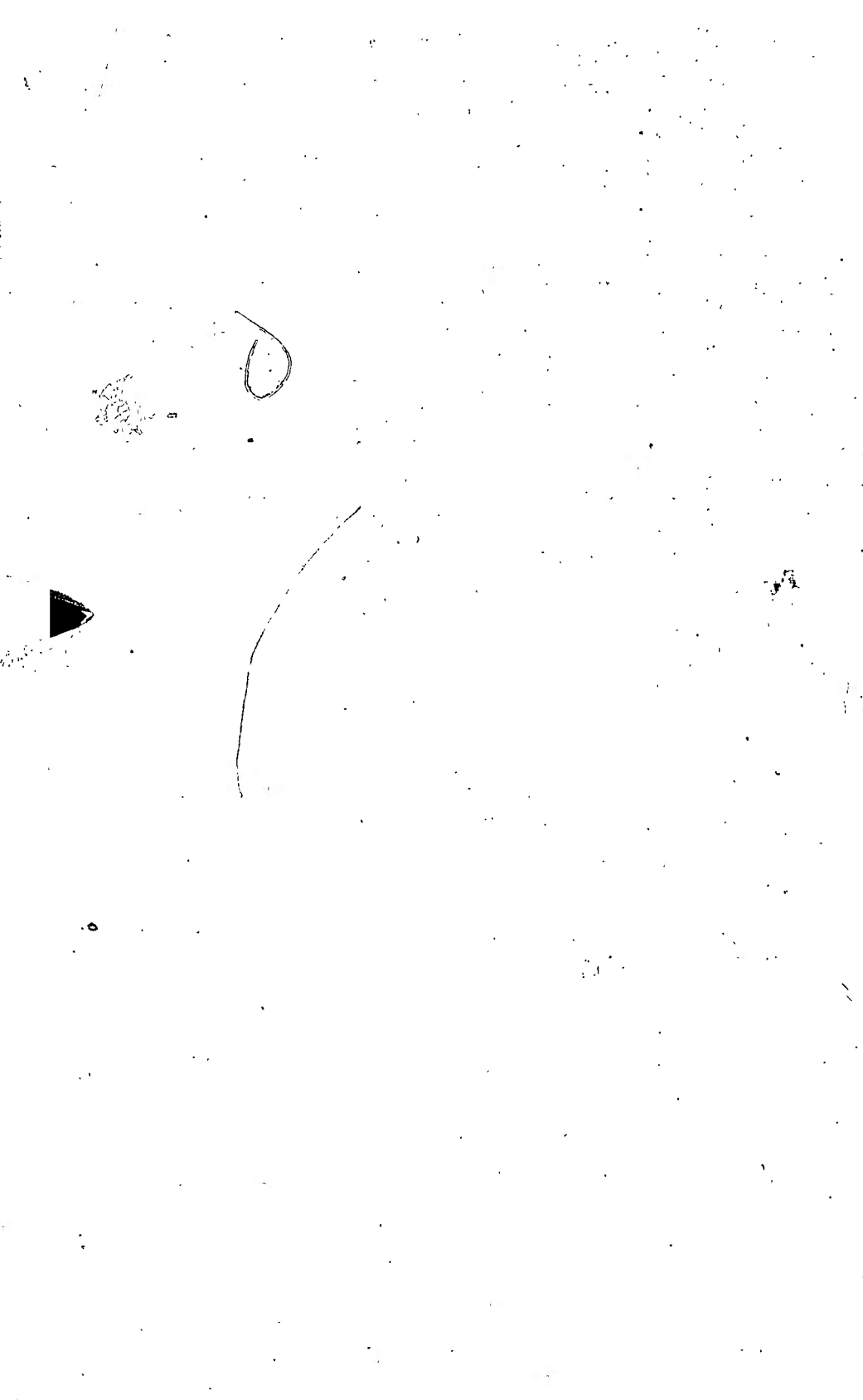


CONTENTS

ACKNOWLEDGMENTS

THE Line Elevator Companies esteem it a great privilege to offer this bulletin to prairie farmers. The information, summarized herein, is up to date and authoritative. The sections devoted to individual insects have been prepared by specialists in the laboratories of the Division of Entomology, Science Service, Dominion Department of Agriculture; and in the Department of Entomology, The University of Manitoba. Contributions are from four laboratories as follows:

Department of Entomology, The University of Manitoba, Winnipeg, Manitoba.
Alfalfa plant bug, western chinch bug, and wheat stem maggot.

Dominion Entomological Laboratory, Brandon, Manitoba.
Grasshoppers, field cricket, Mormon cricket, sweet clover weevil, flea beetles, blister beetles, armyworm, sunflower moth, and Colorado potato beetle.

Dominion Entomological Laboratory, Saskatoon, Saskatchewan.
Wireworms, red-backed cutworm group, (other) armyworms and climbing cutworms.

Dominion Entomological Laboratory, Lethbridge, Alberta.
Say stinkbug, pale western cutworm, beet webworm, hessian fly, and wheat stem sawfly.

It is a pleasure to acknowledge our indebtedness to the Division of Entomology, Dominion Department of Agriculture and, in particular, the individual members of the staff by whom the material was compiled.

In addition to preparing the sections already credited to his Department, A. V. Mitchener, Professor of Entomology, The University of Manitoba, has generously assumed the chief responsibility for editorial detail.

All illustrations are by courtesy of the Division of Entomology, Science Service, Dominion Department of Agriculture. The selection of illustrations was personally supervised by R. D. Bird, Officer in Charge, Dominion Entomological Laboratory, Brandon, Manitoba; and L. B. Jameson, Artist, Division of Entomology, Ottawa, Ontario.

K. W. NEATBY,
Director,
Line Elevators Farm Service.

FIELD CROP INSECTS IN THE PRAIRIE PROVINCES

INTRODUCTION

INSECTS have a more profound influence on our lives than most of us realize. Judged by their effects on our own well being, some insects are beneficial, some harmful and others, perhaps, neutral. Our own complete dependence upon plants and animals for food and clothing and the extraordinarily complex relations among plants, insects and other animals suggest that there can be no complete neutrality. Probably, many insect species are considered harmless because we know so little about their habits and the influences they exert on other living things. Some are mixtures of good and bad. For example, blister beetles sometimes cause serious damage to crop plants and ornamentals, but they also devour large quantities of grasshopper eggs.

HARMFUL INSECTS

Few, if any, economic plants or animals are immune from insect damage. Heavy toll is taken from our livestock, stored food and from our clothing. Insects do serious damage, also, to our field, fruit and garden crops, to our greenhouse plants, shelter belts and to our forests. Our livestock are attacked by many species of flies and lice with the result that gains in weight and milk production are retarded, often seriously. The warble fly merits special attention. It is responsible for an annual loss of about one million dollars worth of leather, ten per cent of our beef and twenty-five per cent of our milk supply. Insects are involved in the transmission of many diseases of human beings and other animals and, also, of plants. This subject is as interesting as it is important, but we must not wander too far afield.

BENEFICIAL INSECTS

Many different insects are not only useful, but indispensable to our well being. The two most valuable insect products are honey and silk. In gathering nectar, from which it makes honey, the honeybee performs the important task of pollinating many fruit and vegetable flowers which otherwise would not set fruit or seed. A large number of species of flies and of wasps spend part of their lives as parasites in the bodies

of other insects, killing their unwilling hosts before they can lay eggs. Still others feed upon the bodies or eggs of injurious insects. Insects preying upon and parasitizing other species are, perhaps, our most important allies in the struggle to protect our own food supply.

HOW INSECTS VARY, GROW, DEVELOP AND MULTIPLY

Variation

An insect is a very, very complicated creature, and it undergoes all sorts of strange experiences between the egg stage and death from old age. About 640,000 different species of insects, now living, have been described. Our ignorance of insect life in the Prairie Provinces is such that no one will hazard a guess as to the number of species that may some day be identified. Our best authority thinks that the number probably lies between 10,000 and 100,000. If we are to make the best use of our insect friends, and protect ourselves and our food from hordes of hungry insect enemies, we cannot know too much about them.

The main purpose of this bulletin is to assist farmers in solving their field crop insect problems. The sections dealing with individual insects have been kept as brief and practical as possible. However, a short preliminary excursion into the insect world, in general, is necessary. No one can write about insects without flourishing larvae, pupae, adults, ovipositors, abdomens and nymphs in front of his readers! In this section, we propose to write with such skilful simplicity that these strange words will become commonplaces.

Suppose you kill an ant without crushing it. Upon careful examination, you will find that the ant is made up of three distinct parts. First, and foremost, is the *head* with two compound eyes, a pair of *antennae* which are complicated but useful sense organs, and mouth parts including powerful jaws. Secondly, in the middle is the *thorax* to which are attached three pairs of jointed legs and, should your specimen be winged, two pairs of wings. The third, and hindmost, part is known as the *abdomen*.

The adults of all insects conform to the general pattern outlined for the ant. Of course a great many wonderful variations on the general pattern are well known even to the most casual observer. Mouth parts have become adapted to many different feeding habits, and they are important in relation to control methods as well as to classification. For example, aphids and mosquitoes have highly specialized piercing and sucking mouth parts, while grasshoppers are equipped with powerful jaws for biting and chewing. Some others, such as mayflies, have only vestigial mouth parts in the adult stage, and do not

eat at all. Their only known function is to mate and produce eggs. Insects with chewing types of mouth parts, like the grasshopper, bite off pieces of the leaves and devour them. Insects with piercing mouth parts, like the aphid, puncture the leaf surface and suck the sap from within. Chewing insects may be poisoned by covering the leaf with poison but obviously this would not be effective against a sucking insect. In order to kill this type we must use an insecticide that kills when it touches the insect's body.

To appreciate the differences in the forms of wings, we need only recall those of dragonflies, butterflies and the hard outer wings, *elytra*, of many beetles.

The hindmost part, or abdomen, varies in a less spectacular way, but females of different species have a wide variety of *ovipositors* adapted to laying eggs in many sorts of different places.

Development and Multiplication

Differences between babies and men, calves and cows or kittens and cats are not great. Babies are afflicted with most of the characteristics of men (even more of women!), and a calf looks much like a small cow. Not so with most insects. Who would guess that, after a rest in a special sort of 'bed roll,' a wireworm would emerge as a click beetle? Or that a cutworm, having settled with your last green pea plant, would take a similar rest, and then blossom forth as a moth? Believe it or not you, who read these lines, now have a tolerably good idea of what is meant by the term *metamorphosis*. In these insects, therefore, we must remember four main stages in development, as follows:

Adult stage— mature forms of flies, butterflies, beetles, etc.
Egg stage— eggs.
Larval stage—larvae (singular, larva), including caterpillars, maggots, grubs, etc.
Pupal stage— pupae (singular, pupa).

From the practical point of view, it is very important to remember that these different stages are characterized by great differences in habit as well as in form. In a few species, the larvae and adults have more or less similar feeding habits as, for example, the Colorado potato beetle. More often, the larvae live and feed under quite different conditions to those preferred by the adults.

Several large groups of insects, including those to which grasshoppers and true bugs belong, do not indulge in such sudden, striking

FIGURE 1—Egg, larval, pupal and adult stages of the June beetle, an insect with complete change in development. About natural size. Drawing F. Hennessey.

changes in form. Instead, they alter less and do it gradually, very much as do higher animals. Almost anyone can recognize a newly hatched grasshopper as such, even though it is very small, and has no wings. The young of such insects are called *nymphs*.

Over-wintering habits of insects vary greatly. Some can survive very cold weather only as eggs, others only as larvae, and so on.

Growth

Insects have what is called an *exoskeleton*. This is a more or less hard substance which completely envelopes the body and appendages, and consists of a material known as *chitin*. It really serves the combined purpose of skin and skeleton. Except when newly formed, chitin will not stretch. Only the joints of appendages (legs, etc.) and the abdomen are flexible on adult insects. Flexibility of the abdomen is due to a series of more or less soft 'rings' which divide the abdomen into *segments*. As a result of this, an insect can only grow by forming a new, more roomy exoskeleton and by shedding the old one. This process is called *moulting*, a term used frequently later in this bulletin. Once the adult form is reached, an insect grows no more.

INSECT CONTROL

Insect control is everything that makes life difficult or impossible for an insect. Insect control may be accomplished in many ways.

We may control insects by the use of appropriate farm practices. Most of these operations are good farm practices which may be performed without additional labour or expense and are timed to destroy the most insects. They consist of (1) summerfallowing, (2) crop rotations, (3) methods of tillage, (4) variations in time or method of planting, (5) destruction of crop residue and weeds, (6) use of resistant varieties, (7) fertilizing and stimulating vigorous growth.

We may control insects with chemicals: (1) By spraying or dusting foliage, upon which chewing insects are feeding, with a poison or by feeding them a poisoned bait. (2) By spraying or dusting sucking or chewing insects with an insecticide which kills them when it touches their bodies. (3) By killing them with poisonous gases. This is very effective when they are in a closed space such as a grain elevator or greenhouse.

We may encourage and increase parasitic insects and insectivorous birds. Laboratories have been established for the increase of parasitic insects and the introduction of parasites from other parts of the world. By planting windbreaks and putting up nesting boxes, farmers may increase insectivorous birds.

We may develop, by breeding methods, varieties of crop plants resistant to insect attack.

Information on Insect Control

The Dominion Department of Agriculture, under its Science Service, maintains a number of laboratories across Canada for the purpose of studying injurious insects and advising on their control. The provincial universities also serve the public in a similar manner. This bulletin is necessarily very brief and in many cases the farmer will want additional information. He is encouraged to write to one of the laboratories situated in his province. For convenience, their addresses are given:

Manitoba— Dominion Entomological Laboratory,
P.O. Box 250,
Brandon, Manitoba.

or

Department of Entomology,
The University of Manitoba,
Winnipeg, Manitoba.

Saskatchewan—Dominion Entomological Laboratory,
c/o University of Saskatchewan,
Saskatoon, Saskatchewan.

or

Department of Biology,
University of Saskatchewan,
Saskatoon, Saskatchewan.

Alberta— Dominion Entomological Laboratory,
Lethbridge, Alberta.

or

Department of Entomology,
University of Alberta,
Edmonton, Alberta.

In requesting information, insect specimens should be sent alive to any of the above addresses. This will enable the laboratory to determine correctly the insect which is causing the trouble, and hence outline more exact control measures. Insect specimens should be placed in a strong cardboard box together with the name and address of the enquirer, and some of their food plants, and mailed without delay.

CHIEF PURPOSE OF BULLETIN

This is not a textbook, but merely a handbook. It will serve as a useful guide to the most destructive of our field crop insects, and to the best control methods at our disposal. If, in addition, a real interest in entomology is developed by even a few of the younger readers, so much the better. This is a fascinating subject enjoyed by many amateurs as well as by professionals.

In the sections that follow, the insects are arranged according to the natural orders to which they belong: Orthoptera, Hemiptera, etc.

ORTHOPTERA

GRASSHOPPERS

Lesser Migratory Grasshopper[1], Two-striped Grasshopper[2], and Clear-winged Grasshopper[3].

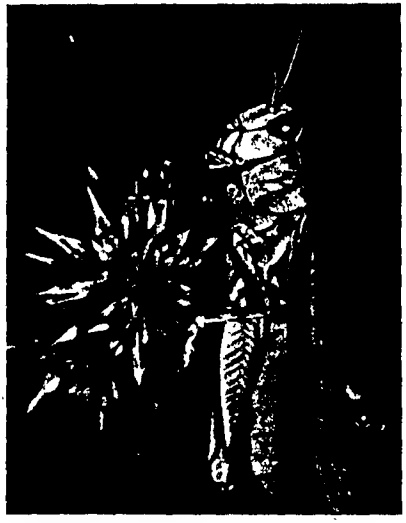


FIGURE 2 — Lesser migratory grasshopper. Adult female resting on Russian thistle. About twice natural size.
—*Photo R. D. Bird.*

GRASSHOPPERS and locusts[4] have plagued mankind since the dawn of history. Locusts are mentioned frequently in the ancient languages of Europe, Asia, and Africa, and a picture of a locust on an Egyptian tomb is believed to have been carved as early as 2400 years B.C. The depredations of locusts or grasshoppers

[1] *Melanoplus mexicanus mexicanus* (Sauss.), Family Locustidae, Order Orthoptera.
[2] *Melanoplus bivittatus* (Say), Family Locustidae, Order Orthoptera.
[3] *Camnula pellucida* (Scudd.), Family Locustidae, Order Orthoptera.
[4] Most of the harmful species of the Old World are locusts. The species in this country are commonly referred to as grasshoppers. Except that locusts are more inclined to live in swarms and have a greater tendency to migrate in bands or swarms, they differ little in appearance or in habits from grasshoppers.

are known on every continent of the earth and they have been an important factor in many of the recorded famines of the Old World. In the New World they have also caused local famines. The development of the Selkirk Settlement on the Red River was retarded in its initial stages because of the ravages of the Rocky Mountain locust. It is probable that they will continue to be a problem for many years to come.

There are approximately sixty-five grasshopper species in Manitoba, seventy-five in Alberta, and an intermediate number in Saskatchewan. Of these, the three species listed above have been the most destructive in Western Canada, although other species, including the red-legged grasshopper, *Melanoplus femur-rubrum* (Deg.), and Packard grasshopper, *M. packardii* Scudd., have been of economic importance at times.

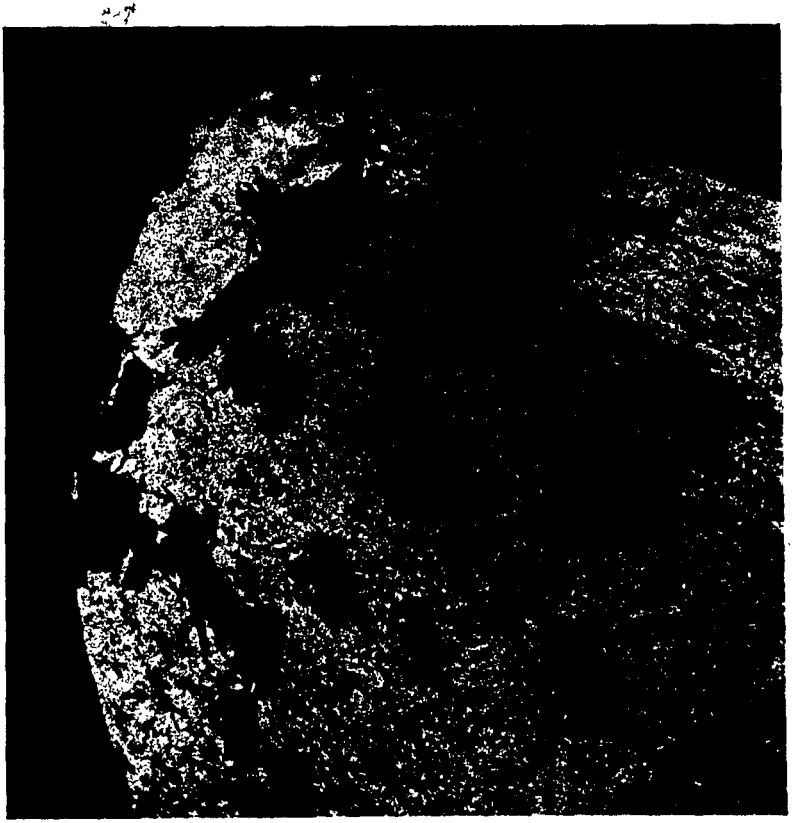


FIGURE 3—Lesser migratory grasshopper nymphs congregating on a stone. Natural size. —*Photo R. D. Bird.*

RECOGNITION

The lesser migratory grasshopper is of medium size and of a dull brownish colour and cannot be distinguished from several species, including the red-legged grasshopper, without a little experience. The two-striped grasshopper is greenish yellow with black markings and is larger than either the lesser migratory grasshopper or the clear-winged

FIGURE 4—Female two-striped grasshopper. About twice natural size.
—*Photo R. D. Bird.*

grasshopper. It can be separated from them in both the adult and immature stages by an unbroken black line along the outer side of the femur, or thicker part, of the hind leg. It gets its name from two yellowish stripes along its back which begin just behind the head and continue to the tip of the wings. The clear-winged grasshoppers vary considerably in colour and markings depending on age and sex. During the first week or ten days after hatching they are black with a white 'collar'. Most of them lose their striking white markings after the first moult and become uniformly dark brown or black. The adult males are small, usually distinctly yellowish mottled with brown markings. The females are greyish brown, considerably larger than the males but with the same mottled appearance.

The egg pods of the two-striped grasshopper are large and may contain as many as eighty loosely arranged yellow eggs. The eggs of the clear-winged grasshopper are neatly and tighly packed into small, compact pods containing twenty to twenty-five eggs each. They are light brown with cream-coloured stripes. The moderately curved pods of the lesser migratory species are elongate and slender with neatly arranged cream-coloured eggs, but neither as uniformly nor as tightly packed as those of the clear-winged grasshopper.

Life History and Habits

The three most injurious species have very similar life histories, but differ considerably in their habits. All three species pass the winter in the egg stage. They rarely begin hatching in the spring before the leaves of the aspen poplar appear. The immature grasshoppers resemble the adults closely except that they have no wings. After moulting, or casting their 'skins', five times, over a period of about six weeks, they are fully grown and their wings are suitably developed for flight. Extensive migrations sometimes occur soon after the hoppers mature and this ordinarily leads to an invasion of areas previously uninfested. With the deposition of eggs, during the summer, the cycle is complete, the adult grasshoppers die, and the eggs remain in the soil throughout the autumn and winter ready to start a new generation in the spring.

The eggs of some of the less common species hatch during the early fall and the young hoppers are fairly well developed by the time winter sets in. These hibernate in clumps of grass, weeds, etc., and appear

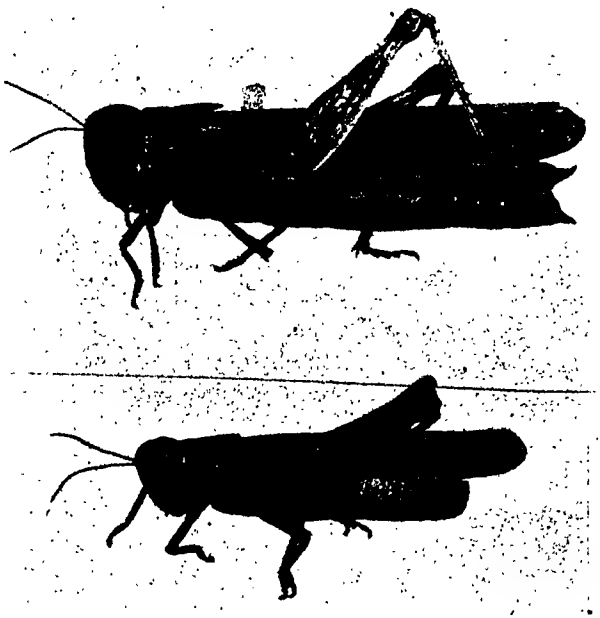


FIGURE 5—Clear-winged grasshopper. Female (above) and male (below). About twice natural size.
—*Photo R. D. Bird.*

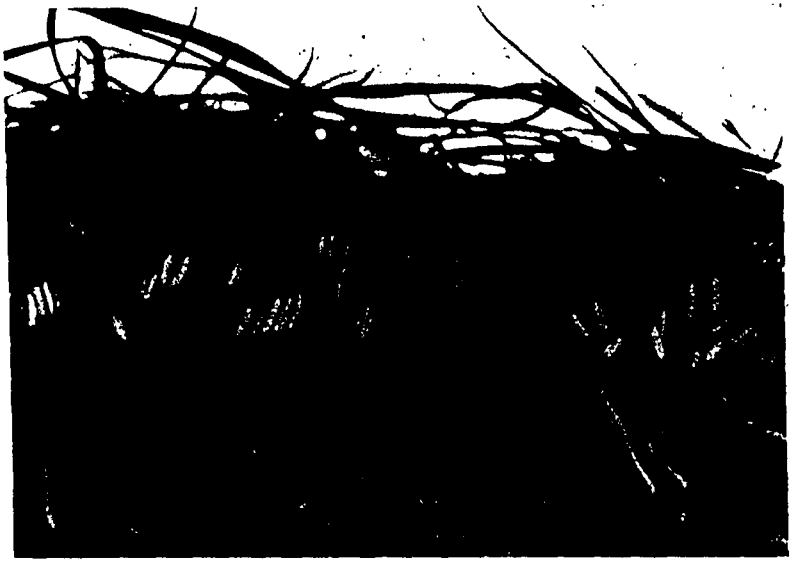


FIGURE 6—Clear-winged grasshopper. Heavy infestation of eggs in section of sod. About natural size.
—*Photo R. D. Bird.*

again in the spring during the first warm days after the snow is gone. They rarely appear in sufficient numbers to do damage but often cause considerable alarm when mistaken for the 'advance guard' of the injurious species.

Most species lay their eggs in the soil in clusters, commonly called 'pods'; but egg-laying sites differ. The clear-winged grasshopper prefers to concentrate on so-called 'egg beds' in grassy areas of roadsides and pastures, although concentrations of eggs have occasionally been found in stubble fields and on ridges of drift soil. In the preferred spots as many as seven hundred pods per square foot, each containing about twenty eggs, have sometimes been deposited. The pods are clustered around grass roots, for the most part, in the top three-quarters of an inch of soil. The great bulk of the eggs of the lesser migratory grasshopper are laid more or less uniformly throughout the stubble fields to a depth of about one inch, but concentrations of eggs are also found in the soil of the more open type of drift ridge. The two-striped grasshopper is the most varied in its egg-laying habits. Eggs of this species are found in almost any of the locations selected by the other species. Some preference is shown, however, for ditch crowns and similar locations where the maximum effect of the sun's rays is felt and some shelter from the wind is afforded.

Damage and Control

The grasshopper populations, as well as the damage they do, are controlled by a number of factors both natural and artificial. Among these are weather, predators and parasites, tillage and poisoned bait.

Weather, both directly and indirectly, has a marked effect not only on the control of grasshopper populations but also on the amount of damage done by a given number of grasshoppers. Thus the disease organism referred to farther on requires moist and moderately warm weather in which to develop satisfactorily. In addition to its influence on disease, weather determines the date and rate of hatching as well as the rate of feeding after hatching is complete. During a cold, backward spring grasshopper eggs begin hatching later in the season and the hatching period is much more extended. Crop growth is not delayed correspondingly. As a result the crop gets a good start and when the hoppers emerge there is more for them to feed upon and damage is not nearly as great. If this is combined with a good, moist growing season the abundance of food is maintained and the hoppers, requiring less moisture, actually consume less than they do during hot, dry seasons. Under such conditions the crops can support a fairly heavy population

FIGURE 7—Oat field destroyed by lesser migratory grasshoppers. —*Photo R. D. Bird.*

without suffering severely. When the reverse conditions obtain, namely, early hatching coupled with hot, dry weather and a sparse crop stand, severe crop injury can be done by a relatively light grasshopper population. Dropping of the heads of the maturing crops, a type of damage done largely by the lesser migratory grasshopper, is somewhat less affected by weather and losses sustained in this way can be quite severe especially when the grasshoppers fly in from other infested areas. However, crop damage that may result in general from a given grasshopper egg infestation is greatly dependent on the weather of the following spring, and is almost as unpredictable.

A considerable number of parasites and predators attack the various stages of grasshoppers. Some of these are more effective than others and deserve special mention. Thus maggots of the beefly, grubs of the blister beetle and larvae of the ground beetle destroy a great many pods of grasshopper eggs. Fleshflies, which are internal parasites of both young and mature grasshoppers, have in some instances been a major factor in controlling outbreaks of the lesser migratory grasshopper. They have been less successful in controlling the other two species. On the other hand there is a fungous disease of grasshoppers, technically named *Empusa grylli* (Fres.) Nowak, which has brought outbreaks of the clear-winged and two-striped grasshoppers to a close, but which has had little or no effect on the lesser migratory grasshopper. Red mites, which are often conspicuous under the wings of grasshoppers, kill very few of them and have little influence on the rise or fall of grasshopper populations.

Tillage of land destroys a high percentage of the eggs, and in areas where fall tillage is extensively practised field infestations are not usually a serious problem. Ploughing to a depth of six inches is known to be very effective, especially when followed by packing. Where the mouldboard plough cannot be used safely, surface tillage is often sufficiently effective to serve as a most valuable control method, especially when used in the fall or *early* spring. Over a large part of the grasshopper area in Saskatchewan and Alberta surface tillage is almost exclusively practised. In this area, where soil moisture is frequently not sufficient to give good grasshopper control by six inch ploughing and packing even were it tried, shallow fall tillage is a valuable aid in the control of intermediate grasshopper egg infestations, but cannot be depended upon in severe infestations. Surface tillage in the spring is considered of rather doubtful value. Thus tillage when it can be fitted in at the right time may save hours of time and tons of material during the baiting season.

FIGURE 8—Barley field severely injured by marginal invasion of two-striped and clear-winged grasshoppers.
—*Photo R. D. Bird.*

The application of poisoned baits is the method most commonly employed for the control of grasshoppers. The bait ingredients in most instances are supplied to the municipalities by their respective provincial governments. The municipalities, in turn, mix the baits and make them available to those having grasshoppers to control. The bait formulae vary somewhat in the different provinces. The following are representative:

Bait No. 1

Sawdust	5 bu.
Flour	1½ gal.
Sodium arsenite	1½ pt.
(or sodium fluosilicate	4 lb.)
Water	4-6 gal.

Bait No. 2

Bran	33 lb.
Sawdust	Bulk twice that of bran
Sodium arsenite	1½ pt.
(or sodium fluosilicate	4 lb.)
Water	10-12 gal.

Best results are secured from bait applied during the morning. Early morning baiting can be practised with good results providing a

warm, sunny day follows. Afternoon baiting rarely gives good results, and baiting during cool, cloudy weather should be avoided entirely.

Forecasting Grasshopper Outbreaks

Individuals of the staffs of the Dominion Entomological Laboratories, located at Brandon, Saskatoon, and Lethbridge, make an annual survey of grasshopper infestations and on the basis of these surveys forecast the probable extent and severity of outbreaks likely to occur the following year. While the accuracy of these forecasts depends a great deal on the vagaries of the weather, as outlined above, they have proved very helpful in organizing campaigns for grasshopper control.

FIELD CRICKET[1]

The common black field cricket can be present in considerable numbers without doing much injury to crops. On occasion, however, particularly during dry weather it damages flax bolls. It also tends to collect in the stooks of grain where it makes itself still more unwelcome by cutting the bands of the sheaves. The species occurs in almost every settled district of Canada and in the years 1932 to 1935 it was common in Western Canada. It was especially abundant in the Red River Valley where it caused a great deal of annoyance by invading living quarters.

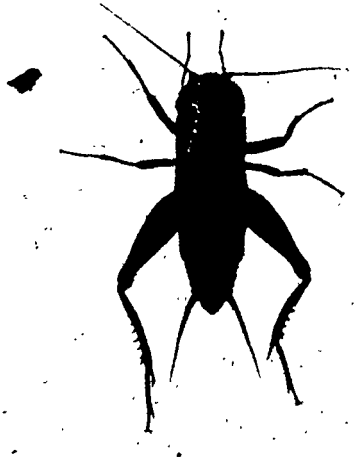


FIGURE 9—Adult male field cricket. About twice natural size. —*Photo R. D. Bird.*

Recognition

The field cricket is rarely mistaken for anything else by even the most casual observer, hence little or no description of it is required. It is a black insect, more or less rectangular in outline, measuring slightly more than half an inch in length. The outer wing covers are fairly large but the

[1] *Gryllus assimilis* (F.), Family Gryllidae, Order Orthoptera.

inner ones are commonly not developed sufficiently for flight. The hind legs, like those of the grasshopper, are designed for jumping. The female has a moderately long, spear-shaped ovipositor. The males have rasping organs on the wing covers which make possible their characteristic chirping sound.

Life History and Habits

The elongate, slender, milky white eggs are almost an eighth of an inch in length. They are laid singly during late summer and fall and remain all winter in the soil. Hatching occurs in the early summer. The tiny crickets resemble the adults except that they are wingless. After moulting six or seven times the adult stage is reached. As soon as the adults are sexually mature, egg-laying begins again and the life cycle is complete. There is only one generation per year.

Field crickets are more active at night than they are during the day, but they often can be observed feeding during cool, cloudy days. They are very active creatures and when disturbed, especially in bright, warm weather, they dart under the nearest object which will serve as cover. Field crickets feed on almost anything, vegetable or animal. They are decidedly cannibalistic and during seasons when they are numerous often form black lines down the highways over the mutilated bodies of their fellows that have been crushed by passing cars. The adults appear to be particularly fond of the seeds of various grasses and weeds and it is this tendency which probably accounts for the occasional attacks on flax bolls.

Control

Crickets can be controlled by means of poisoned bait. Since they feed mostly at night the bait should be scattered during the late afternoon or evening. The ingredients should be as follows:

Bran	25 lbs.
Sodium arsenite	½ pt.
(or Paris green, white arsenic or calcium arsenate	1 lb.)
Water	2½ gal.

Binder twine is treated ordinarily with a repellent which prevents damage by field crickets. If any twine is secured that has not been so treated, it can be rendered immune from attack by smoking it in a manner similar to that employed in the home-curing of hams.

MORMON CRICKET[1]

As far as the Prairie Provinces of Canada are concerned, the Mormon cricket is a curiosity rather than a pest. In the Rocky Mountain states, however, from Colorado to Montana, sporadic outbreaks of this insect have been recorded since 1847, and damage to crops is often severe. Its first appearance as a pest of cultivated crops occurred in the Mormon settlement in the state of Utah. It is probably this fact, together with a superficial resemblance to the common black field cricket, that gave it the name Mormon cricket. It belongs, however, not to the cricket family but to the group of insects more correctly called long-horned grasshoppers.

FIGURE 10—Adult female Mormon cricket. About natural size. —*Photo R. D. Bird.*

[1]*Anabrus simplex* Hald., Family Tettigoniidae, Order Orthoptera.

Recognition

The adults are robust, clumsy insects, practically wingless, measuring about one and one-quarter inches in length. Both males and females have antennae longer than the body, hind legs greatly enlarged and elongated for jumping, and a saddle-like shield on the thorax. The female can be distinguished from the male by its sword-shaped ovipositor which is nearly an inch in length. The occasional specimen encountered in the Prairie Provinces may be either dark green, brown or nearly black.

The nymphs, or young Mormon crickets, resemble the adults except in size and minor variations in colour. They cast their skins seven times before reaching maturity.

The elongate, slightly curved, greyish eggs are not deposited in groups like those of the grasshoppers, but are laid singly in the earth.

Life History and Habits

The winter is passed in the egg stage. Hatching occurs in early summer, the exact date depending a great deal on the latitude and on the type of season. Growth is completed by midsummer. Egg-laying begins in July and extends through to September, the eggs remaining in the soil to hatch during the following spring. Thus there is only one generation per year.

The Mormon cricket has a very wide range of food plants, both wild and cultivated. Both forage and cereal crops are attacked in the early stages, but the main damage to cereals occurs after the crop has headed at which time the crickets devote most of their attention to the kernels. They are particularly attracted to garden crops and when present in number keep the plants eaten off right to the ground. Small fruits have little or no chance to develop, being stripped from the bushes as soon as they appear. Thus in areas of severe infestation, growers have little opportunity of producing anything for their livestock, for marketing, or even for their own consumption.

Control

The Mormon cricket can be controlled effectively by the use of a poisoned bait somewhat similar to that used for controlling grasshoppers. For best results, however, it is essential that bran form at least part of the carrier and that sodium fluosilicate be used as the poison.

Of the natural control factors birds are the most important. The Utah outbreak of 1847, which occurred before artificial control methods were perfected, was brought under control by gulls. A monument erected in honour of the gulls still stands in the grounds of the Mormon temple in Salt Lake City.

HEMIPTERA

SAY STINKBUG[1]

SAY stinkbug is a comparatively new pest of grains in Western Canada and is capable of causing serious damage. The first record of its occurrence in appreciable numbers was made in 1935. From that date until 1941, this insect increased in numbers and extent of area infested in Alberta and southwestern Saskatchewan with accompanying crop losses in many districts. The extremely wet season of 1942 reduced the numbers over the prairies and practically no damage was reported. When weather conditions become more nearly normal, it is anticipated that Say stinkbug will again increase and cause damage in many areas.

RECOGNITION

The adult is a robust, bright green, typical stinkbug, about one-half of an inch long and one-quarter of an inch wide, with minute white specks and three small, pale spots on the forward margin of the conspicuous central triangular portion. During the summer the adults are quite green, but when in hibernation assume a dark brown red colouration.

The immature bug is called a nymph and is wingless. Its growth is in five stages, each separated by a moulting of its skin. The newly

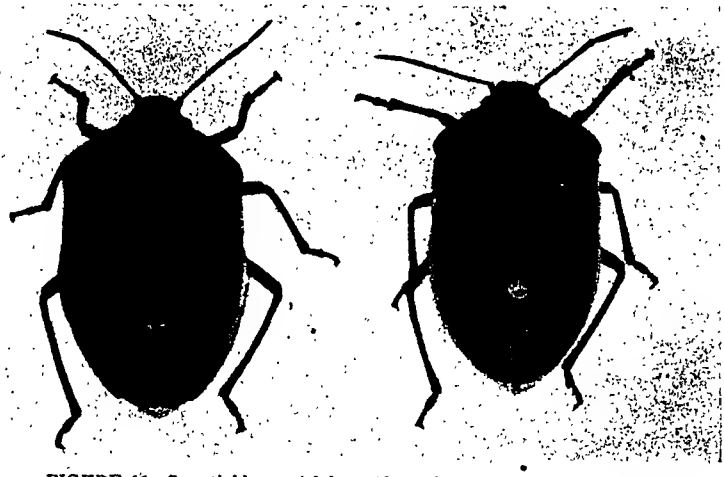


FIGURE 11—Say stinkbug. Adults. About three times natural size.
—*Photo R. D. Bird.*

[1]*Chlorochroa sayi* Stal., Family Pentatomidae, Order Hemiptera.

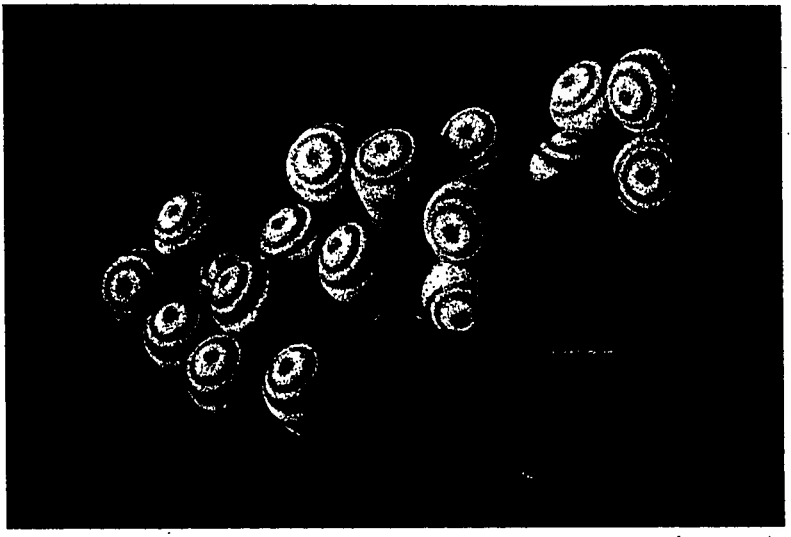


FIGURE 12—Say stinkbug. Eggs. About six times natural size.
—*Photo R. D. Bird.*

hatched nymph is small, about one-sixteenth of an inch long, and brown or black in colour. During the later stages the colouration becomes more green as size increases.

The egg is very small, about one thirty-second of an inch across, greyish white in colour with dark concentric rings on the top. The eggs are laid in clusters, averaging about fourteen to thirty eggs per cluster, on stubble, dead weeds, wheat heads and growing vegetation.

Plants Attacked

Economic damage to cereal crops is largely confined to wheat, although oats, barley and flax also are damaged to a lesser extent. Other plants on which damage has been noted include sugar beet seed crops, alfalfa, beans, peas, sunflowers, grasses and garden crops.

Damage to Wheat

Wheat is damaged as a result of the head being pierced by the insect and the liquid contents of the developing grains consumed. This results in the production of badly shrivelled, light weight kernels. The effect on yield, of course, depends largely upon the extent of the infestation. The injured plants manifest no external symptoms even though feeding is extensive and damage great.

Life History

Say stinkbugs pass the winter in the adult stage, clustered together under weeds and trash. Nymphs occasionally enter hibernation, but are unable to withstand winter temperatures. Prior to hibernation, adults and nymphs cluster together around Russian thistle plants and enter their winter quarters permanently by the first period of sub-freezing weather with snow. The hibernating stinkbugs remain inactive throughout the winter and emerge in the spring with surprisingly low mortality. With the advent of warmer weather in the early spring the adults leave their winter quarters, resume activity and begin feeding, usually on weeds and volunteer grains. Mating starts about the first of May and egg-laying occurs a short time later. The first eggs are laid by over-wintering adults between May 10th and May 15th and oviposition continues as long as the adults survive. The eggs hatch about June 1st and the nymphs feed on weeds. The nymphal period is completed in about a month and adults of the first generation appear about the first week of July. These adults feed on growing crops and cause damage. Their appearance is usually coincident with the early heading of grain, thus the crops are in a very susceptible stage just when adults are abundant.

The adults of the first generation mate and begin egg-laying within a short time of their emergence. Oviposition is usually general by about August 1st. Nymphs commence hatching about ten days to two weeks after the eggs are laid. First adults of the second generation usually appear in the field during the second week of September. The two generations make it possible for this insect to increase rapidly when conditions are suitable. Adults of both generations enter hibernation to carry on for another year.

Control Measures

The burning of weeds and trash in which the grain bugs are congregated is an effective means of control. This is secured most efficiently in the early spring when the over-wintering adults congregate each night under weed and trash accumulations along roadsides, in ditches and along fence rows. These should be burned in the early morning before the bugs become active and move away in search of food. During midsummer, burning can be carried out by setting fire to dry weed accumulations where adults and nymphs have clustered together.

Under certain conditions, where nymphs and adults are present in weedy stubble fields, excellent control can be obtained by ploughing, particularly if the insects can be buried to a depth of two inches or more.

In all efforts toward the control of Say stinkbug, the individual must assume the responsibility of recognizing the presence of the pest, appraising the situation and employing the best method of attack.

ALFALFA PLANT BUG[1]

Recognition and Characteristic Injury

The alfalfa plant bug was the subject of a thorough study made by John H. Hughes at the University of Minnesota which resulted in the publication of a technical bulletin in June, 1943. The information contained in this bulletin has been used freely in the preparation of the following material.

FIGURE 13—Alfalfa plant bug. Adult. About six times natural size.
—*Photo C. L. Morier.*

In the field, adult alfalfa plant bugs are green or greenish-yellow tinged with brown. They average about three-eighths of an inch in length. They have piercing-sucking mouth parts and feed upon the sap which they obtain by piercing the buds, flowers and soft seed pods of alfalfa plants. The injury which results from this feeding is believed to be due to the injection of some toxic substance through the insect's mouth parts as well as to mechanical injury. Flowers upon which the insect has fed soon wither and drop off.

Damage and Geographic Distribution

It is believed that the injury done by the alfalfa plant bug interferes seriously with seed setting in alfalfa fields. There are, of course, other contributing causes for poor sets of seed, but injury by this insect has been proven to be an important one. The alfalfa plant bug, which is now widely distributed in Manitoba, was first recognized here in 1941. It is likely to extend its distribution over most of the area in Canada and United States where alfalfa is grown. Already it has been recorded from many of the States, particularly in the north-central area. It occurs in Europe, Asia and Africa and now is spreading rapidly in North America to which continent it found its way only recently.

[1] *Adelphocoris lineolatus*, (Goeze), Family Miridae, Order Hemiptera.

Life History

There are two broods of the alfalfa plant bug each year in Manitoba. The winter is passed in the egg stage within alfalfa stems in the field. These eggs hatch in May after which the young nymphs begin feeding on the new growth. First brood adults have been taken in Manitoba during the last few days of June and were plentiful in the fields during early July. The adult females of this generation lay their eggs within alfalfa stems and these produce a second generation of adults by early September. The adult females of the second generation lay the eggs that survive the winter in the stems of alfalfa plants.

Control

Burning alfalfa fields in early spring, as soon as the old plants are dry enough to burn, kills the over-wintered eggs. Great care must be taken to prevent the fire from getting out of control. Any local regulations with respect to burning stubble, etc., should be observed carefully. To be effective the burning must be thorough as any unburned portions of the field will serve as points from which nymphs will spread to the adjoining crop.

WESTERN CHINCH BUG[1]

Recognition and Characteristic Injury

The adult western chinch bug is a small insect about one-eighth of an inch in length. Two forms occur in the field at the same time, one with wings extending to the tip of the abdomen and another form with short wings. The membranous part of the wing is milky coloured, and the under part of the body is dark brown in appearance. The nymphs, or immature forms, are reddish in colour and because of this are decidedly more conspicuous than the adults.

The western chinch bug has piercing and sucking mouth parts which enable it to feed upon the sap of the host plant. Most noticeable damage is done along the edge of a wheat or barley field adjoining an old brome grass pasture or a roadside where brome grass has grown for many years. The infestation develops over a period of years in the brome grass, which is mostly killed eventually, and the western chinch bugs are forced to leave the field in search of food. The bugs work into the field and attack the wheat along the edge. Injury is indicated by the dead and dying crop along the edge of the field where a bare strip of land widens as the days pass. From a distance, the effect is similar

[1] *Blissus occiduus* Barber, Family Lygaeidae, Order Hemiptera.

to that of invading clear-winged grasshoppers. The insects feed on the plant stems just below the surface of the ground where they may be found by removing the topsoil around the plants that are not dead but just beginning to be affected.

Damage and Geographic Distribution

Damage to wheat and barley fields occurs during the last week of May and the first half of June. The recorded damage in Manitoba is confined to the Red River Valley and in that area of it south and west of Winnipeg. In Saskatchewan there are records of injury to crops in the south-central and southwestern areas. The damage is complete along the edges of fields, often extending into the fields for several rods. Old brome grass fields have been thinned to the point where they are of no further use as pastures. This insect is, however, of relatively minor importance at the present time.

Control

Control is easy and direct. Plough down the injured marginal area of the grain field. The land should be ploughed from the edge of the field to a point a few rods beyond where the land is bare, since many of the bugs will be working in the grain where it is still green but stunted. If it is not too late in the season, barley may be sown upon this land after it has been made ready for the seeder. The infested old brome grass pasture or roadside area should be ploughed down as soon as possible. Where these recommendations have been followed control has been very effective.

COLEOPTERA

WIREWORMS[1]

In the Prairie Provinces, wireworms are among the most important insect enemies of young wheat, and many other field and garden crops. They are native insects, commonly associated with grasslands both of native and cultivated types. However our chief species is often abundant in old farmlands where no grass, other than cereals, has been grown for many years.

Recognition and Characteristic Injury

All four stages, adults, eggs, larvae and pupae, live in the soil, though the adults often move about on the surface during the spring. Eggs and pupae are rarely seen.

[1] *Ludius cerciipennis destructor* Brown, (and other species) Family Elateridae, Order Coleoptera.

Adults usually measure one-quarter of an inch to one-half of an inch in length, are slow-moving, dark-coloured 'click' beetles—so named because they are able to right themselves when placed on their backs, by throwing themselves into the air by a sudden movement accompanied by a clicking sound.

Larvae are about one inch long when fully grown, with straight slender hard bodies, pale yellow or yellowish-brown in colour and shiny as though varnished. This is the stage that does the damage.

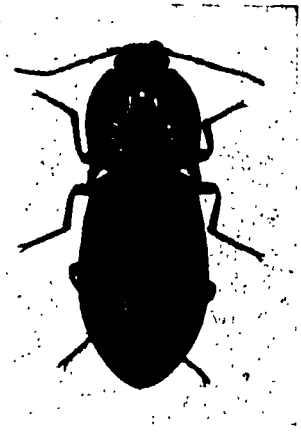


FIGURE 14—Click beetle. Adult stage of the wireworm. About four times natural size.
—*Photo R. D. Bird.*

Wireworms start their attack as soon as the crops are planted, boring into seeds and tubers. Seeds are eaten out, usually leaving only the husks. Seedlings are often killed, being shredded below ground but not cut off, the central shoot usually dying first (Plate II, lower left).

Damage and Geographic Distribution

The damage occurs chiefly in the spring, although feeding continues throughout the summer and early fall, and serious injury may result then to some garden plants especially potato tubers which are often

FIGURE 15—Wireworm larvae. About three times natural size.
—*Photo R. D. Bird.*

ruined commercially by the boring of the larvae. With wheat, severe damage is over when the plants stool out, but before that time the stand is often ruined in small or large patches (Plate II, upper left). Characteristically, some plants are left along drill-wheel tracks. Corn and sunflowers also suffer severely. Damage is usually much worse to crops planted on summerfallow. While distributed generally over the Prairie Provinces, wireworms are most troublesome in loam soils of the prairie and open parkland. In heavy clay soils they are seldom abundant except for a few years after grassland is broken.

Life History

Wireworms develop much more slowly than most of our other insects. From five to ten years are required by the most destructive wireworm species to complete a life cycle. The pest is a very persistent one because of this and the fact that neither adults nor larvae move very far. Each year some of the larvae mature and change in late July to pupae. From these the beetles soon emerge, but remain in the soil during the winter. The adults begin to appear on the surface as soon as the soil becomes warm in spring but egg-laying does not take place until June. The eggs soon hatch in the soil and the long period of larval life begins.

Control

Cultural methods are the only practical means of controlling wireworms, but excellent results can be secured if the best farming procedure is used. In a word, control consists of frequent good summerfallowing, together with the use of the best seeding methods to protect the crops seeded on summerfallow or rebroken grassland. The first gradually reduces wireworm infestations, where they are bad, or prevents them from increasing too seriously. The second gives an immediate reduction of damage, by offsetting the extra activity of the pest after the fallow year. In summerfallowing, it is essential to keep the field free of weeds, especially volunteer grain and grasses, from the middle of June to the end of July. Tillage should not be deeper nor more frequent than is necessary for weed control, in order to insure a firm seed bed as well as for economy.

In seeding, the three main points are:

(a) Use the heaviest rate of seeding recommended for your district.
(b) Treat the seed with a mercury dust; avoid formalin.
(c) Use a press drill, or follow immediately with a heavy packer.

The methods of control applicable to gardens, where the pest is difficult to deal with, are too involved to be described here.

COLORADO POTATO BEETLE[1]

The Colorado potato beetle is a native insect which feeds on the potato and related weeds. It readily attacked the potato when it was introduced by the settlers. From its original home along the eastern slopes of the southern ranges of the Rocky Mountains it has spread to most districts of the continent where the potato is grown. It is the most injurious insect on potatoes in the Prairie Provinces.

Recognition and Characteristic Injury

Adults are hard-shelled, convex beetles, one-quarter of an inch to three-eighths of an inch long with five black and five yellowish stripes that run lengthwise on each wing cover.

Eggs are yellowish-orange in colour, and are deposited in clusters on the under sides of potato leaves.

Larvae are about one-half of an inch long when fully grown, hump-backed, orange to red in colour with two rows of black spots along each side (Plate I, upper right).

Damage and Geographic Distribution

Adult beetles eat the young potato plants in the spring. Larvae attack the foliage in late June and July, and a second generation of adults and larvae appear in August. Plants may be so severely damaged that they die, or the yield may be greatly reduced. This insect is distributed generally throughout the potato growing area of the Prairie Provinces.

Life History

The adult beetles pass the winter in the soil at a depth of from two to seventeen inches. They come out of the ground in the spring, fly about, and attack young potato plants. Each female lays up to five hundred eggs in clusters on the under side of the leaves in early June. The eggs soon hatch, and the larvae grow rapidly. When fully grown they enter the soil, where each one forms a cell and after passing through a resting pupal stage emerges as an adult in late July. These new adult

[1] *Leptinotarsa decemlineata* (Say), Family Chrysomelidae, Order Coleoptera.

beetles lay eggs, and a second generation of adults may appear in late August. These adults, as well as some of the later ones of the first generation, enter the soil to pass the winter.

Control

In order to save the potato crop, control of the Colorado potato beetle is essential. The larvae are easily killed, but repeated applications of poison are required to destroy successive hatches. Arsenical dusts or sprays may be used. Generally, the dusts are preferred on account of their ease of application. Recommended formulae are:

Dust—1 lb. of calcium arsenate, lead arsenate or Paris green thoroughly mixed with 10 lb. of hydrated lime. Apply to the upper surfaces of the leaves when wet with dew on a calm day. Repeat every ten days as long as damage is evident.

Spray—Calcium arsenate or lead arsenate (5 teaspoonfuls to 1 gallon of water), or Paris green (3 teaspoonfuls to 1 gallon of water and 6 teaspoonfuls of hydrated lime). Repeat the application at ten day intervals during period of infestation.

SWEET CLOVER WEEVIL[1]

The sweet clover weevil is a European beetle which was first recognized in Manitoba in 1939. Since then it has spread throughout much of Manitoba, Saskatchewan and North Dakota.

Recognition and Characteristic Injury

The adult weevil is not easily seen as, on being disturbed, it drops off the plant upon the soil which it resembles in colour, and feigns death. If one remains quiet, the beetles will begin to crawl around after a few minutes. They are about three-sixteenths of an inch long. The damage is easily recognized. Crescent shaped pieces a quarter of an inch or more across are eaten out of the leaves. Small plants in the spring may be completely defoliated and killed. Damage is usually worst at field margins and to isolated plants (Plate I, upper left).

Damage and Distribution

The sweet clover weevil confines its attention mainly to sweet clover, although it will occasionally attack alfalfa to a limited extent. It is

[1] *Sitona cylindricollis* (Fahr.), Family Curculionidae, Order Coleoptera.

particularly destructive in the Red River Valley and other sections of southern Manitoba and southeastern Saskatchewan. Some farmers have stopped growing sweet clover on account of the ravages of the beetle, and beekeepers have become alarmed at the reduction of this important honey crop. Damage is worst in the spring when the plants are becoming established, but if there are good rains sweet clover can often outgrow the effects of defoliation. Severe defoliation may again occur in August along the margins of fields particularly when they are adjacent to other clover fields that have been cut for hay and ploughed.

Life History

Winter is passed in the adult stage under trash in and about fields of sweet clover. In the spring the weevils migrate and attack sweet clover in adjacent fields. Eggs are laid on the soil and larvae feed on the small roots of the second year's growth of sweet clover. Pupation takes place in the soil and adults of the next generation emerge in late July and early August. There is an overlapping of the two generations although the over-wintering beetles are dying off by this time.

Control

The sweet clover weevil is difficult to control. It cannot be satisfactorily poisoned and suggested control measures are largely cultural. Ploughing after taking off the first crop in July will kill some of the larvae and pupae, and destroy hibernating quarters, but may drive the remaining adults into adjacent fields. Planting of sweet clover as far as possible from last year's crop and in rotation with other crops will help to reduce damage.

FLEA BEETLES[1,2]

The term 'flea beetle' is applied to a group of very small beetles which have their hind legs enlarged for jumping. When disturbed, they jump like fleas.

Recognition and Characteristic Injury

On account of the small size of the adult, the type of injury is often seen before the beetles are noticed. Small holes are eaten through the leaves so that they look as though they had been peppered with small shot.

[1] *Phyllotreta* spp., Family Chrysomelidae, Order Coleoptera.
[2] *Epitrix cucumeris* (Harr.), Family Chrysomelidae, Order Coleoptera.

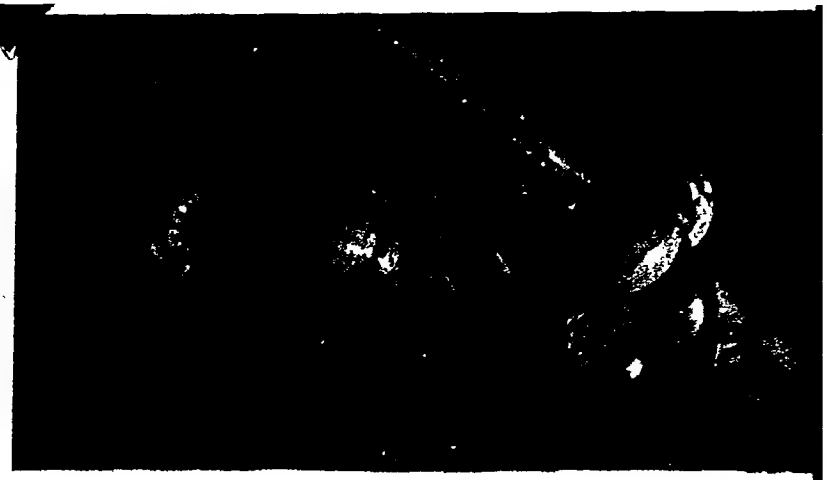


PLATE I

UPPER LEFT: Sweet clover plant defoliated by sweet clover weevil. Note crescent shaped notches in leaves.

—Photo R D. Bird.

UPPER RIGHT: Potato beetle larvae feeding on potato leaf. About natural size.

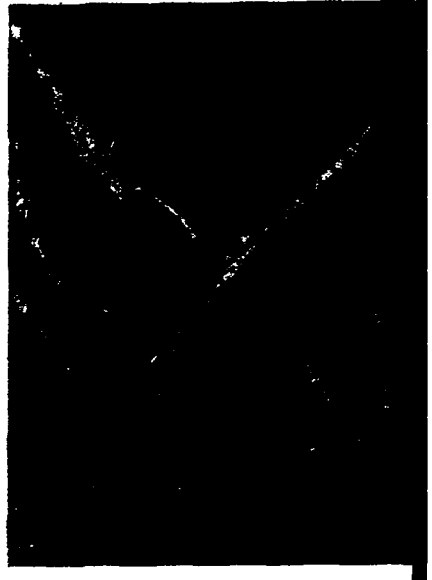
—Photo R. D. Bird.

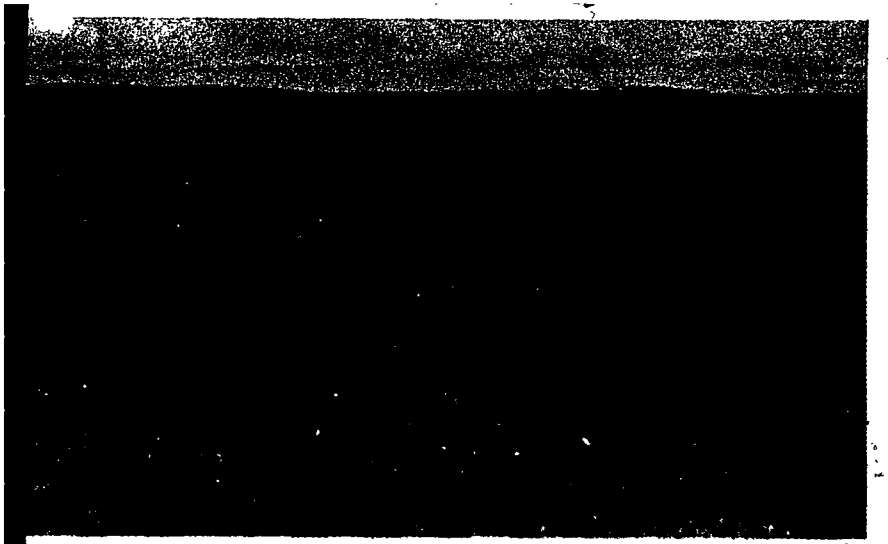
LOWER LEFT: Red-backed cutworm and young flax plants which it has cut. About one-half natural size.

—Photo W. B. Fox.

LOWER RIGHT: Flea beetles feeding on pods of rape. About natural size.

—Photo R. D. Bird.





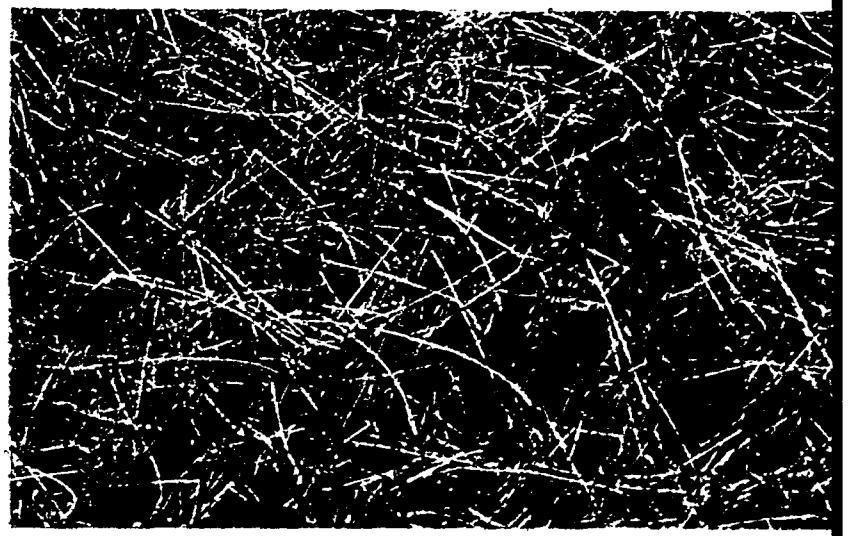


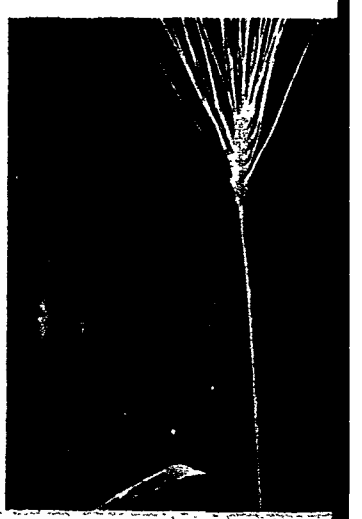
PLATE II

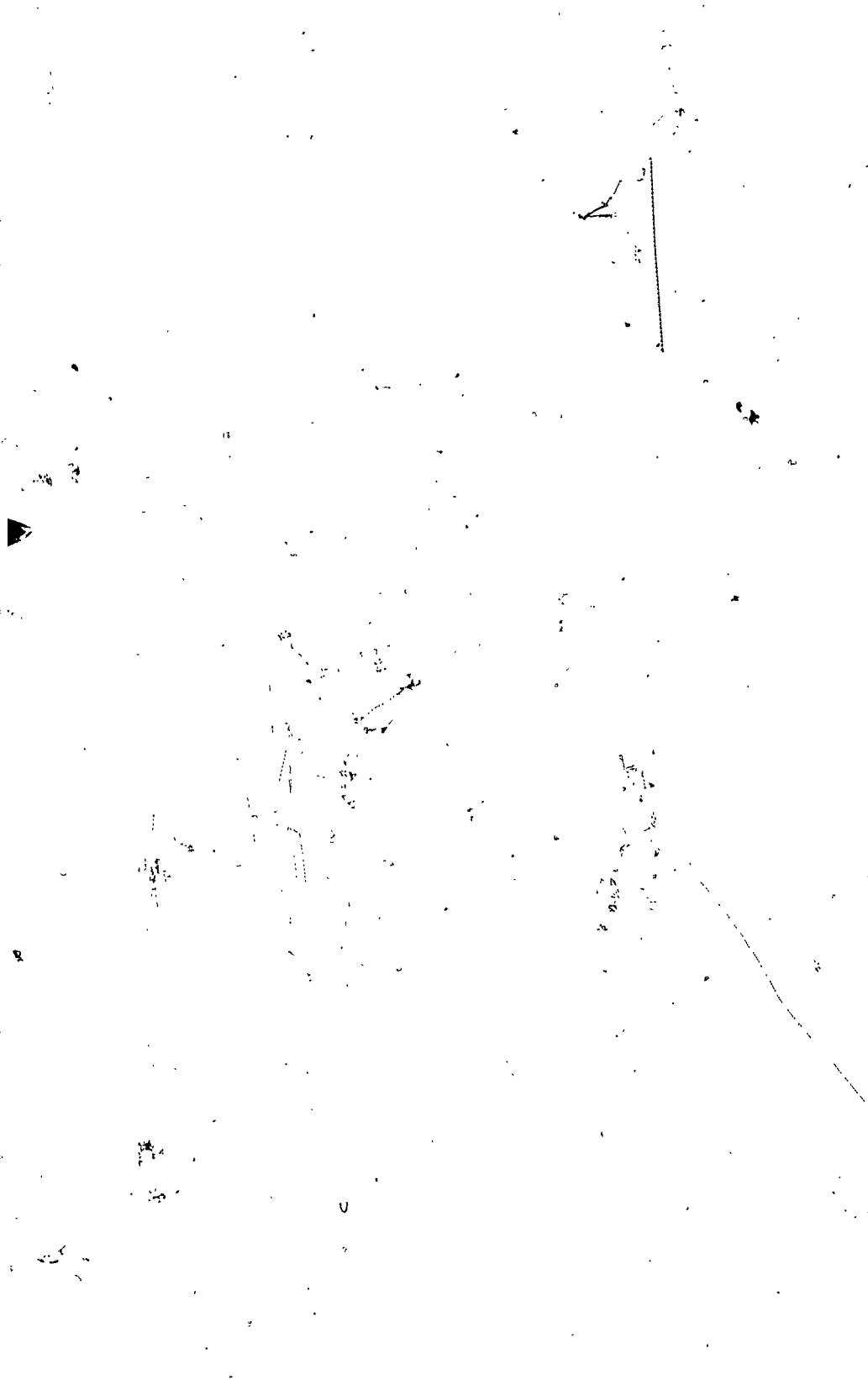
UPPER LEFT: Fifty acre field of wheat severely injured by wireworms.
—*Photo R. D. Bird*

UPPER RIGHT: Wheat cut by the wheat stem sawfly, and missed by the binder.
—*Photo R. D Bird*

LOWER LEFT: Wheat plants injured by wireworms, compared with normal plant of same age.
—*Photo R. D Bird*

LOWER RIGHT: White head caused by wheat stem maggot. Note upper leaf remains green.
—*Photo R. D. Bird*





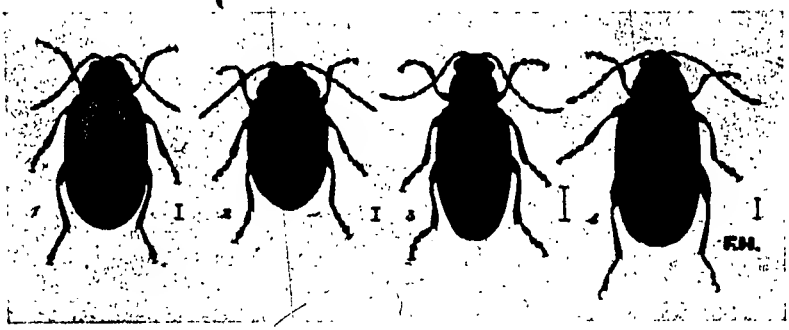


FIGURE 16—Left to right: Potato flea beetle, red-headed flea beetle, cabbage flea beetle and turnip flea beetle. Approximate size indicated by line beside each insect.
—*Drawing F. Hennessey.*

Adults are about one-twelfth of an inch in length, the size of a pencil point. They are usually black in colour but some have white stripes (Plate I, lower right).

Eggs are not seen as they are laid in the soil.

Larvae usually feed on the small roots of the host plants. They eat into potato tubers and cause small pimples.

Damage and Distribution

Adult beetles attack a variety of broad-leaved plants, particularly rape, turnip, sugar beet, cabbage, cauliflower, radish, and a number of weeds. The potato flea beetle usually attacks only potatoes. Flea beetles occur across the prairies but are particularly destructive in Manitoba. They are a serious pest in gardens and, in 1943, destroyed a small acreage of sugar beets in Manitoba. Close watch should be kept for them in sugar beet and rape fields as they are capable of doing extensive damage when the plants are in the first and second leaf stages. The beetles eat small holes in the leaves and may destroy so much of the leaf surface that the plants are weakened or killed.

Life History

Our common flea beetles over-winter as adults under trash in and about fields and gardens. They come out with the first warm weather and attack the young plants as they appear above the ground. Eggs are laid in the soil and the small, whitish larvae attack the roots of the plants upon which the parent beetles were feeding. When fully grown the larvae pupate in the soil and emerge as beetles in late July and in August. They commonly attack the leaves of the host plant and feed until the first fall frosts. Some of the over-wintering beetles are still alive when the first adults of the next generation appear.

Control

Flea beetles are not easily killed with arsenical poisons. The best control has been obtained with prepared derris dust. Dusting with cryolite diluted with two parts of flour is also recommended. Destruction of trash and weeds in the neighbourhood of fields and gardens where susceptible plants are grown will help to hold flea beetles in check. For the potato flea beetle, Bordeaux mixture has given good results and is usually combined with a poison spray for Colorado potato beetles. The combined formula is copper sulphate (bluestone), 4 lb.; hydrated lime, 6 lb.; arsenate of lime, 1½ lb. to 40 gallons of water.

BLISTER BEETLES

Nuttall Blister Beetle[1], Shiny Black Blister Beetle[2], and Ash-grey Blister Beetle[3].

Blister beetles are so called because when a paste made from dried and pulverized beetles is applied to the skin, blisters are produced. This was supposed to have a medicinal value. A European species, known as the Spanish-fly, was commonly used, but our species have the same blistering property. The beetles are not poisonous to birds but the flesh of chickens that have fed on blister beetles is poisonous to man.

Recognition

Adult blister beetles are elongated, soft-bodied insects, one-half of an inch to three-quarters of an inch in length. The most common ones are black or grey. One species has metallic, plum coloured wing covers and a green body.

Eggs are cream coloured and are laid in clusters in the soil.

Larvae live in the soil. Our common species feed on grasshopper eggs.

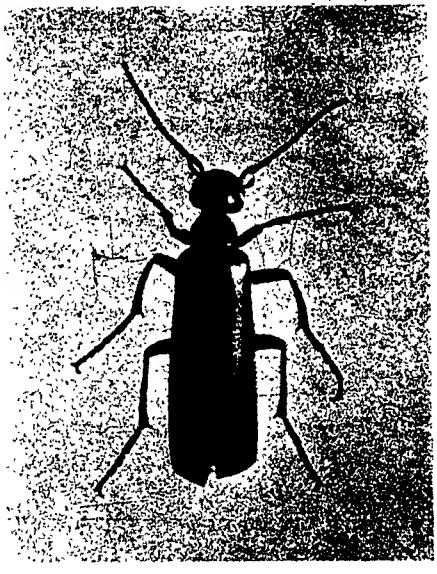


FIGURE 17—Shiny black blister beetle. About three times natural size.
—*Photo R. D. Bird.*

[1] *Lytta nuttallii* Say, Family Meloidae, Order Coleoptera.
[2] *Macrobasis subglabra* Fall, Family Meloidae, Order Coleoptera.
[3] *Macrobasis fabricii* (Lec.), Family Meloidae, Order Coleoptera.

FIGURE 18—Blister beetle, and damage to caragana. About 1½ times natural size.
—*Photo R. D. Bird.*

Damage and Geographic Distribution

Adult beetles occur suddenly in swarms and, after feeding ravenously for a few days, disappear. They are particularly fond of plants of the pea family; such as, soybeans, sweet clover, caragana and broad beans, but they also attack potatoes. They occur generally across the prairies, but are particularly abundant in areas of grasshopper outbreak.

Life History

Blister beetles have a most remarkable life history. In addition to the usual adult, egg, larval and pupal stages, the larvae pass through a number of stages differing from each other in form and habit. Adults are leaf feeders while the larvae of our common species feed on the eggs of grasshoppers. Blister beetle eggs are laid in clusters in the ground. The young larva is very active and seeks out a grasshopper egg pod upon which it completes its development. It usually destroys the complete pod of about twenty-five grasshopper eggs. Winter is passed in one of the late larval stages. Pupation takes place in the spring and adults emerge in July.

Control

Blister beetles, although they are highly beneficial in destroying grasshopper eggs, sometimes occur in such numbers on their food plants

that they must be controlled. The best results have been obtained with barium fluosilicate, diluted with three parts of flour, dusted on the beetles and on the plants upon which they are feeding. Under war-time conditions barium fluosilicate may be difficult to obtain. Cryolite shows considerable promise as a poison, but has not been fully tested on blister beetles. As blister beetle larvae are dependent on grasshopper eggs for food, good control of the grasshoppers will help to keep the blister beetle population down.

LEPIDOPTERA

PALE WESTERN CUTWORM[1]

THE pale western cutworm first appeared in injurious numbers in Alberta in 1911. Since that year outbreaks have been frequent in Alberta, Saskatchewan, Montana, North Dakota, and occasionally farther south.

Recognition

The pale western cutworm is of a uniform slate-grey colour with a light yellowish head, on the front of which are two, distinct, short, black dashes.

Nature of Damage

The first-stage cutworms are very small and they feed almost entirely above ground. They are seldom noticed and their feeding activities consist of cutting notches and holes in the leaves of young plants. After the larvae start feeding below ground, the plants are usually cut off and a small portion of the underground stem is eaten. This causes the portions of the plants above ground to wilt and die. If there is sufficient soil moisture, new shoots may spring up from the old roots but if not, the roots also die.

Life History

The pale western cutworm is the larval stage of a moth or 'miller' which flies during the last three weeks of August and the first week of September.

The moths begin to lay eggs soon after they have emerged and the eggs are laid only in soft soil. When the surface of the soil is caked or crusted, conditions for egg-laying are unsuitable and the female will

[1] *Agrotis orthogonia* Morr., Family Phalaenidae (Noctuidae), Order Lepidoptera.

FIGURE 19—Pale western cutworm. Adult. About 2½ times natural size.
—*Photo R. D. Bird.*

seek some other location where the surface is dusty. The eggs usually remain unhatched in the ground until spring. They begin to hatch when the temperature rises above freezing, provided there is sufficient soil moisture so that the eggs are wet. The maximum hatching takes place at temperatures between 50° and 70° F. If the eggs become dry, hatching may be delayed or the eggs may be killed at these or higher temperatures. On rare occasions hatching may take place in the autumn and then the insects live through the winter as partially grown cutworms.

FIGURE 20—Pale western cutworm laying eggs in loose soil. About twice natural size.
—*Photo H. L. Seamans.*

The newly hatched larvae are very small, about one-eighth of an inch in length, and almost colourless. They may live in the soil for several weeks without food of any kind and only begin feeding when vegetation other than stinkweed *(Thlaspi arvense* L.) starts to show above the soil surface. When the larvae have reached the third stage

or are about one-quarter of an inch long, they rarely come to the soil surface and all feeding is done below ground. They feed throughout May and the first half of June until they have reached a length of one and one-half inches. At this time they are fully grown and form small cells in the soil about three inches below the surface. They remain in these cells for a time, feeding occasionally, and finally change to dark brown pupae, from which the moths emerge later.

Natural Control

The natural control of the pale western cutworm is brought about by both parasites and predators. The parasites may be other insects or diseases which live either on or in the cutworms and eventually kill them. Predators are other animals such as insects, birds, or mammals which more directly attack and devour the cutworms.

Forecasting Cutworm Outbreaks

It is possible to foretell, with reasonable certainty, a year in advance what the cutworm situation is likely to be. It has been found that when the fields are too wet to use a disk-harrow the cutworms are likely to be on the surface, and a day with the soil in such a condition, whether raining or not must, therefore, be considered as a 'wet' day in forecasting. When it is not actually raining, an observation in the field will be required to determine the moisture condition of the soil and whether or not it could be disked easily. Since weather conditions only during the period of larval activity appear to have any influence on the increase or decrease of the cutworm population, it is impossible to use definite calendar periods for making observations. A hot, dry May will cause the cutworms to develop rapidly, so that they may be mature by the middle of June, while a cold spring may so retard development that larvae are still feeding in July. If weather conditions, and especially the soil moisture, are observed during the period in which the majority of the cutworms are active and feeding, a forecast of the probable conditions for the next season can be made quite accurately by using the following method:

> If there are fewer than ten 'wet' days during the period of larval activity, there will be an increase in the number of cutworms the following year.
>
> If there are between ten and fifteen such days during the period of larval activity, there will in all probability be some decrease in the number of cutworms the next year.
>
> If there are more than fifteen 'wet' days during the period of larval activity, little trouble may be looked for from this insect the following year.

Control Measures

Activities for the control of the pale western cutworm start with the forecasting of the outbreak for the next year. Any individual farmer can usually complete the forecast for his own district by July 1st. If the forecast shows that the pale western cutworm will probably be abundant the next season, plans should be made immediately to reduce the chance of loss to a minimum. There are two control measures which have proven to be very effective, but both must be used before the spring crop is seeded. These two measures are: (1) the prevention of infestation and (2) the starvation of young cutworms. There are other control measures which have been advocated at various times, but they are not effective, or at least have very slight value.

Prevention of Infestation

It is quite possible to prevent the pale western cutworm from seriously infesting fields, by the use of suitable cultural practices. Only the fields to be used in the production of a crop need be protected as the cutworms do not migrate to neighbouring fields from infested land not in crop or in course of being summerfallowed. Since the moths always select a place where the soil surface is soft and dusty, in which to lay their eggs, the location of the infestation during any year is largely determined by the condition of the soil surface during the egg-laying period the previous year. Fields which are to be summerfallowed must be worked early, and thoroughly cultivated during June and July to destroy all weeds. ALL WORK ON THE FIELDS TO BE PROTECTED FROM CUTWORM INVASION MUST BE STOPPED BY AUGUST 1ST, AND THE FIELDS LEFT UNDISTURBED UNTIL THE MIDDLE OF SEPTEMBER. This will allow any showers to form a crust over the surface of the soil, thereby making such ground unsuitable for laying eggs. If this crust is not broken up by cultivation or any other means during the time the moths are flying, the field will be reasonably free from cutworms the following year. Stock should not be allowed to run over this summerfallow, as they will break up the crust as effectively as will cultivation. It must be realized fully that the effectiveness of this control of the infestation is dependent on showers or heavier rainfall in July or early in August to crust the soil surface effectively. The presence or absence of weeds or stubble has little to do with the egg-laying and a crusted weedy field is in a much better condition to avoid infestation than a clean dusty field.

Fields which are in a crop which cannot be harvested before August 1st or left until the middle of September are very liable to infestation

the following year. Wherever possible such fields should be summerfallowed the following year, especially if the forecast for an outbreak indicates that cutworms are likely to be present. If a fall grain crop is to be sown it is advisable to seed before August 1st, if possible; if not, the seeding should be left until after the middle of September. Fall sown wheat and rye are not immune from cutworm attack and seeding during August is sure to leave the field with a soft and dusty surface.

In areas subject to soil drifting, the prevention of infestation cannot always be relied upon to insure cutworm-free fields in the spring. Eggs are carried with the drifting soil and in this way may be deposited in many places far removed from the point where they were laid. Under such conditions fields which were well crusted during the egg-laying period have frequently been found to be severely infested with cutworms wherever drift soil lodged.

Starvation of Young Cutworms

The very young pale western cutworms can be destroyed by starvation in the open field if, after they have started to feed and develop, their food supply is destroyed for a period by cultivation. This method can be utilized in the control of this pest in infested fields. TO RID AN INFESTED FIELD OF CUTWORMS BY STARVATION, THE SPRING CULTIVATION SHOULD BE DELAYED UNTIL WEEDS AND VOLUNTEER GRAIN ARE FROM ONE TO TWO INCHES ABOVE THE SURFACE OF THE GROUND. AT THIS TIME THE WHOLE FIELD SHOULD BE THOROUGHLY CULTIVATED, LEAVING THE SOIL 'BLACK', AND SEEDING SHOULD TAKE PLACE ONLY AFTER A DELAY OF TEN DAYS FROM THE TIME THE CULTIVATION WAS COMPLETED.

The cutworm eggs, as has been mentioned, hatch about the time the frost is out of the top two inches of the soil and the young caterpillars go without food until green vegetation shows above the ground. If this green vegetation, either weeds or volunteer grain, is allowed to grow until it is one or two inches high, the cutworms, which at this stage live above ground, will have begun to feed and to develop. It is after they have started to develop that they are most susceptible to starvation. Hence the importance of allowing the weed growth to start and the importance of thorough cultivation later. If an infested field is cultivated before the weed growth has occurred, the predevelopment, foodless period of the larvae is simply prolonged. If the field is seeded immediately after cultivation, the germinating grain simply serves as a new food supply for the cutworms, and if cultivation is delayed until the cutworms have reached the third stage, when they

feed underground the cutworms are merely disturbed and can survive indefinitely on buried vegetation and sprouting weeds. The delay in seeding is necessary to make sure that no new food supply is provided for the young cutworms. Some of the cutworms will die within a few days after the cultivation, but many of them will survive for a week or ten days. When the seeding is delayed ten days practically all of the cutworms will have died before the crop comes up.

Stinkweed should not be used as an indicator for the time to cultivate as this weed usually comes up under the snow and is not fed upon by the pale western cutworm.

Examine fall wheat and fall rye as soon as it comes up in the spring. If half of the plants show signs of cutworm feeding on the leaves, the crop is probably doomed and should be cultivated out and the field reseeded in ten days to a spring crop.

Control Measures NOT Recommended

Packing, rolling, harrowing, disking, or using a press drill make little difference in the amount of damage that may be done by cutworms. If there are not many cutworms present in the field, a thorough packing of the soil across the drill rows will retard the progress of the cutworms and reduce the damage. If there are more than fifteen cutworms per square yard they will destroy the crop in spite of the most careful packing.

No effective poisoned bait for the pale western cutworm has yet been discovered. There are some conditions under which any poisoned bait would be effective, but the chances of having the bait ready when the conditions are right for using it are so slender that it is not economical.

No seed treatment or soil poison has been found which is economically effective.

Where the infestation in a field is very patchy and there is danger of these patches becoming larger, a furrow may be ploughed around them with a straight side towards the uninjured grain. This furrow will not stop the movements of the cutworms, but it will retard their progress and turn some of the larvae back into the part of the field already injured.

RESEEDING

THERE IS DANGER TO A SECOND SEEDING IF IT IS SOWN TOO SOON AFTER THE FIRST CROP HAS BEEN DESTROYED BY THE PALE WESTERN CUTWORM. Unlike some other cutworms, this species does not move out of a field after the crop has been destroyed. The larvae remain

where they are and feed largely on weeds or old straw and stubble in the soil. It can be readily realized that as these cutworms are able to destroy the first crop while they are still rather small, they will do as much damage to a second seeding, especially as the grain is smaller and the cutworms somewhat larger. Practically all field crops are subject to attack by the pale western cutworm and the reseeding of any crop in an infested field is risky. Flax, oats, and barley are as readily eaten as is wheat; but can be sown, after the cutworms have disappeared, with reasonable certainty of getting a crop.

RED-BACKED CUTWORM GROUP AND OTHER SPRING CUTWORMS OF SIMILAR HABIT

Throughout the Prairie Provinces cutworms are among the most important pests of field and garden crops. In the parkland and forest area, and also in irrigated districts, it is the red-backed cutworm group which is predominant; while in the open prairies, it is the pale western cutworm. At the margins of park and prairie the two types often occur together during outbreaks, thus creating a special problem since there are important practical differences in control. Widespread outbreaks of the red-backed cutworm[1] usually occur every few years, often lasting for several years at a time.

Recognition and Characteristic Injury

Adults are inconspicuous moths, with the body about an inch long and with a wing spread of one and one-half inches. They fly at night and are seldom seen except when they come to lights, usually in rather small numbers.

Larvae are about one and one-quarter inches long when fully grown, and have soft, fleshy dull-coloured bodies and the habit of curling up when disturbed (Plate I, lower left). With the red-backed cutworm the upper half of the body is of a moderately dark grey colour with two broad stripes of dull red running along the back. In the several other species of similar habits that may be associated with it, especially in gardens, the upper half of the body is of darker shade than the lower half (note difference from the pale western cutworm) but the dull red stripes down the back may be indistinct or lacking. Cutworms destroy plants by cutting completely through the young stems at or just below the soil surface. Red-backed cutworms come to the surface, in search of food on warm nights, except that when the soil is very loose and dry the older larvae may keep below the surface.

[1] *Euxoa ochrogaster* (Guen.), Family Phalaenidae (Noctuidae), Order Lepidoptera.

Damage and Geographic Distribution

Red-backed cutworms are troublesome in gardens nearly every spring. During outbreaks, severe losses also occur in field crops, such as sweet clover, flax, sunflowers, barley and oats. Wheat is seldom attacked heavily by the red-backed cutworm. This cutworm is most troublesome in the soils of light and medium textures, and the damage is often especially conspicuous on knolls. While normally restricted to the park and forest area, during outbreaks the red-backed cutworm may be abundant well out into the prairie area and it commonly occurs there in irrigated districts.

Life History

Damage normally takes place from late in May through the first three weeks of June. When the cutworms are fully grown they change to reddish-brown pupae in earthen cells in the upper few inches of the soil. The moths emerge about the middle of July, and during August lay their eggs in the soil. Each female moth is capable of laying one thousand eggs or more, so that this pest can increase very rapidly under favourable conditions. The eggs lie dormant throughout the winter but hatch during the first warm weather after the snow has gone. There is thus an annual life cycle, and the fields infested one year are not necessarily the ones that were infested the previous year.

Control

Poisoned bran bait is an effective and practical control for the red-backed cutworm. Scatter the bait (see formula below) thinly over infested fields about dusk on warm calm evenings. Baiting is more effective if done early in the season and particularly when the soil surface is slightly damp from recent rains.

To minimize infestations on fields being summerfallowed, weeds should be destroyed in late July, and the fields left undisturbed throughout August, unless a heavy weed growth develops.

Reseeding of damaged fields can be undertaken as soon as the red-backed cutworms have been poisoned. If not poisoned, the field should not be reseeded until the cutworms have ceased feeding, usually about June 20th.

POISONED BAIT

	Small quantity	Larger quantity
Bran	2 quarts	25 pounds
Paris green or arsenate of lime	2 teaspoonfuls	½ pound
Water, to moisten, about	2 cups	2½ gallons

Thoroughly mix the bran and poison while dry; then stir the water into the poisoned bran until all is well dampened, but not wet enough to drip.

Where available, sodium fluosilicate is an especially valuable poison for cutworm baits, and is used at twice the rate of Paris green. Molasses is often an ingredient in cutworm baits; but is omitted in this formula because its value has not been established experimentally.

CAUTION—Keep all poisons and equipment where they cannot be reached by children and livestock. Avoid inhaling poisonous dusts. Do not allow poison to get into cuts or sores.

ARMYWORM[1]

The armyworm occurs suddenly in scattered outbreaks which are usually only of one year's duration. It is a native insect which feeds chiefly on wild grasses, but natural control occasionally fails to keep it in check and it invades grain fields in army-like hordes.

Recognition and Characteristic Injury

Adult moths are of the common 'miller' type that come to light. They are a uniform pale brown colour with a wing expanse of about one and one-half inches. They may be distinguished from other moths of this type by a small white dot near the centre of each front wing.

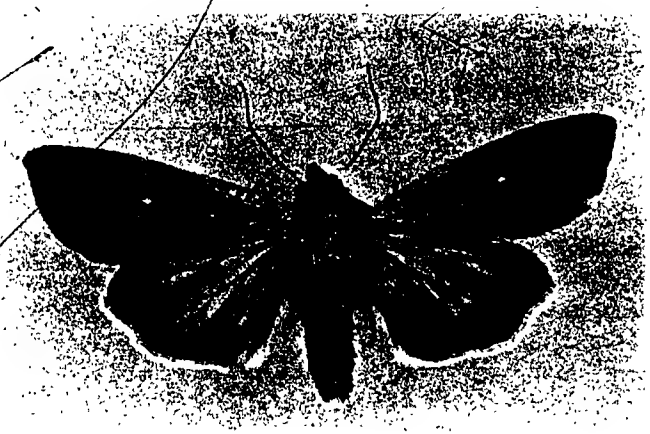


FIGURE 21—Adult armyworm moth. About twice natural size.
—*Photo R. D. Bird*

[1]*Cirphis unipuncta* (Haw.), Family Phalaenidae (Noctuidae), Order Lepidoptera.

Eggs are laid in clusters on the lower leaves of grasses.

Large numbers of dark green *larvae*, one-half of an inch to two inches long, with light stripes running down the middle of the back and along the sides, observed stripping of the leaves off grains and grasses are almost sure to be armyworms. They occur in late July.

FIGURE 22—Armyworm larvae. About natural size. —*Photo Dominion Department of Agriculture.*

Pupae, which are dark brown in colour and about three-quarters of an inch long, are found in numbers under clods of earth in the field.

Damage and Distribution

Damage is most frequently done to heavy stands of lodged grain, usually oats. The leaves are first stripped off and then the panicles are cut off. Armyworms occur generally but are more prevalent in the park belt, especially in the neighbourhood of heavy grass, slough bottoms and creeks.

Life History

Armyworms pass the winter as partially grown larvae among heavy stands of grass. They feed and complete their development in the spring, pupate and emerge as adults in late June. These moths lay eggs which hatch in a few days. The eggs may be laid on grain, in which case the larvae develop in the field. It often happens, however, that the eggs are laid on grass adjacent to the field. When the larvae have devoured this grass they migrate in an army into the field. It is these armies that give the name to the insect. It will usually go through a grain field and eat the lamb's quarters, pigweed and Russian thistle and leave the grain untouched. Armyworms feed at dusk and on dull days. On bright days they hide under clods of earth. Larvae are fully grown at the end of July or early August. They pupate in the soil in the field and emerge as moths about two weeks later. These moths lay eggs on grass, and these hatch and develop into partially grown larvae before winter sets in. There are, therefore, two generations per year.

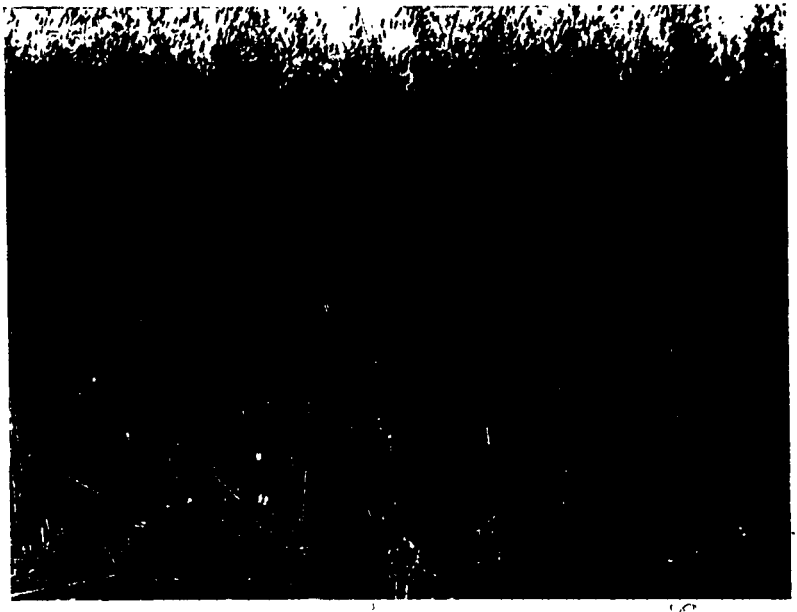


FIGURE 23—Oats stripped of leaves by armyworms.
—*Photo R. D. Bird.*

CONTROL

Parasites and other natural control factors usually keep armyworms in check and prevent their occurrence at the same place two years in succession. When outbreaks occur the farmer must act promptly in order to save his crop. Armyworms may be poisoned by the use of a bait composed of 25 lb. of bran and 1 lb. of arsenate of lime or Paris green mixed thoroughly and moistened with water. The bait should be spread thinly at the rate of about 20 lb. per acre, in the evening when the armyworms are feeding. If an army is entering a field, a deep furrow ploughed in advance of the armyworms will help to check them. The furrow should be ploughed so that the soil is thrown to the side from which the armyworms are advancing. A log drawn up and down the furrow will pulverize the soil and make it difficult for the armyworms to climb up the other side. Many armyworms will also be crushed by the log as they pile up in the furrow. Bait spread on the field side of the trench will kill most of the armyworms that get over the furrow. If the armyworms are well into a field before they are noticed, prompt cutting, stooking, and capping will save some of the crop. If the majority of the armyworms are two inches long they will pupate and damage will cease in a few days.

FIGURE 24—Ditch ploughed to trap advancing armyworms.
—*Photo R. D. Bird.*

OTHER ARMYWORMS AND CLIMBING CUTWORMS

There are several common kinds of climbing cutworms which, although not major pests in the Prairie Provinces, attack a variety of crops and often cause considerable losses. Some of these, when abundant, may 'march' some distance and hence are called armyworms. (See also the beet webworm, which farmers often refer to as armyworms.) Among these are the bertha armyworm[1], the wheat-head armyworm[2], and the flax bollworm[3].

Recognition and Characteristic Injury

Adults are night-flying moths which are similar to the many other species of cutworm moths. They come to lights occasionally, but otherwise are seldom seen.

Larvae are about one and one-quarter inches to one and one-half inches long when fully grown. They have soft bodies, like the cutworms, but with much greater colouration, usually in the form of several stripes along the back and sides. Our more important species, while often similar in appearance, are usually distinguished by the

[1] *Barathra configurata* (Wlk.), Family Phalaenidae (Noctuidae), Order Lepidoptera.
[2] *Protoleucania albilinea* (Hbn.), Family Phalaenidae (Noctuidae), Order Lepidoptera.
[3] *Heliothis ononis* Schiff., Family Phalaenidae (Noctuidae), Order Lepidoptera.

plants which they attack and the areas in which outbreaks occur. Feeding occurs typically on the heads and upper leaves of the host plants. With most of the species, the larvae tend to be inactive during the day when they may hide in the soil or under debris.

Damage and Geographic Distribution

The *wheat-head armyworm* is a native insect which occurs more or less commonly on cereal crops and grasses in the prairie area of Saskatchewan and Alberta. In 1941 it caused considerable damage to wheat

FIGURE 25—Bertha armyworm attacking flax. About natural size.
—*Photo R. D. Bird.*

and barley by eating into the ripening kernels. Some alarm also resulted when numbers of the worms were found in loads of grain that had been straight combined. The numerous stripes of the larvae are usually of pale shades, so that the worms are not easily seen on the plants.

The *bertha armyworm* occurs in occasional outbreaks on sweet clover, flax and cabbage. Grains and grasses are not attacked. These outbreaks seem to have taken place mostly along the margin of the park belt and open prairie extending some distance into both, and also in irrigated areas. The larvae may vary in colour from a pale green shade to one in which almost the entire back is black except for slight lines and a distinct yellow stripe down the side.

The *flax bollworm* is a climbing cutworm of recent occurrence that is known to attack only cultivated flax and a few weeds, such as wild flax and cow cockle. Although it is present throughout the Prairie Provinces, serious losses have occurred only in some districts in Western Saskatchewan, where damage was first reported in 1942. The worms, which live inside the boll until partly grown, are a dull green shade with four white lines. They eat out the seeds, leaving an empty boll with a round hole in the side.

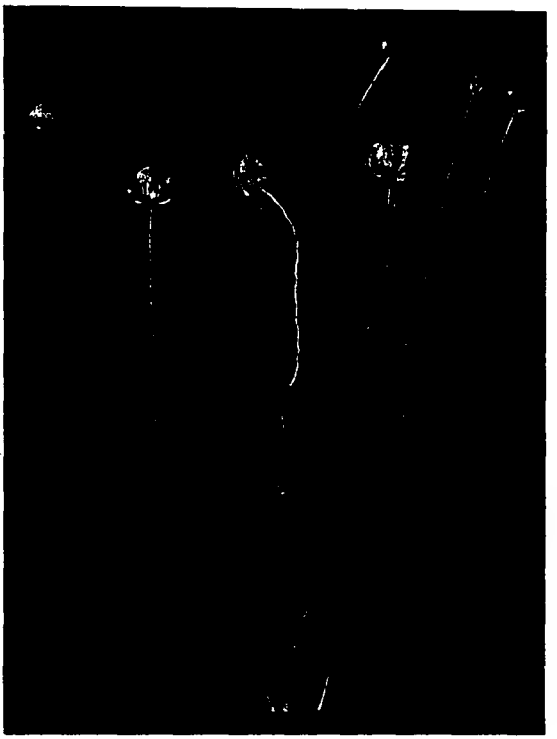


FIGURE 26—Flax bollworm attacking flax. About natural size.
—*Photo W. B. Fox and H. McDonald.*

Life History

With the armyworms and most of the other common climbing cutworms, the damage occurs in midsummer or just before harvest. When the larvae have finished feeding they enter the soil and change to the reddish-brown inactive pupae. With most of these species the winter is passed in the pupal stage, the adult moths not emerging until the next summer. The eggs are laid upon plants suitable for food for the larvae. The eggs soon hatch, but it takes two or three weeks before the larvae are large enough to cause noticeable damage.

Control

Severe infestations of the bertha armyworm on flax can be controlled by dusting the crop with an arsenical mixture. On cabbage, a rotenone dust should be used, as it is not dangerous to humans.

There is no satisfactory control at present for the wheat-head armyworm and the flax bollworm. However, for the wheat-head armyworm, the worst infestations may be avoided if wheat and barley are not seeded on the stubble of crops in which the pest was present the previous year.

BEET WEBWORM[1]

Description

The adult beet webworm is a small greyish-brown moth about one-half of an inch to three-quarters of an inch in length. When numerous, the moths may be seen clustered around flowering plants, feeding on the nectar of the flowers. They are frequently seen rising in clouds from weeds or cultivated crops when disturbed. There are two generations a year, but usually not more than one severe infestation of larvae.

Life History and Habits

The flat, pearly scale-like eggs are laid singly or in overlapping groups usually on the under sides of the leaves of lamb's quarters or beets or on the various parts of the leaves or stems of Russian thistle. The eggs hatch in about seven to ten days.

The young larvae feed chiefly on the under sides of the leaves and at this stage are green in colour, making it difficult to see them readily. If disturbed, however, the young larvae drop from the leaf and hang from a silken thread. They later become darker in colour, with black stripes and circles along the back. When fully grown they are about one inch in length and slender.

If food becomes scarce the larvae may migrate in large numbers, and are then sometimes incorrectly called armyworms. When migrating they tend to follow straight lines and may go up and over even such obstacles as houses or fence posts rather than go round them.

Food Plants and Damage

Beet webworms feed on a wide variety of native and cultivated plants. Lamb's quarters and Russian thistle are favoured host plants, while almost all garden crops are attacked. If weeds are scarce they may feed on succulent grain crops, but in general these are immune to attack. Flax and alfalfa may be severely injured. In some cases even trees have been defoliated. It is not uncommon to see garden or weed patches stripped of all leaves and left blackened where a migration has passed.

[1]*Loxostege sticticalis* (L.), Family Pyralidae (Pyralididae), Order Lepidoptera.

FIGURE 27—Beet webworm on sunflower. About twice natural size.
—*Photo R. H. Painter.*

Control

Careful, complete examination of susceptible crops to determine the presence of eggs or young larvae and early, thorough treatment are essential for satisfactory control. In the case of well developed larvae the crop may be injured severely even after control measures have been applied. For this reason early treatment is advisable and, in the case of migration, treatment of weeds in the line of march may prevent much actual crop loss.

In combatting migrating bands, where possible, a barrier ditch filled with water around the area to be protected or at least along the side from which the webworms will enter is very effective. If the water is standing in the ditch the addition of a little used crankcase oil will increase its efficiency.

Paris green spray, 1 lb. to 20 gallons of water to which 1 lb. of laundry soap has been added, has given good control. Paris green dust made by thoroughly mixing 1 part of Paris green to 8 parts of hydrated lime or cheap flour will give equally good control. In the control of this pest on sugar beets, dusts composed of 1 part of Paris

green to 5 or even 3 parts of lime are sometimes used. Thoroughness of application, however, is more important than increasing the strength of the mixture.

Recent experiments indicate that proprietary agricultural dusts of pyrethrum or derris give very satisfactory control. These dusts kill chiefly by contact and should be directed against the larvae themselves. The pyrethrum dusts appear to be faster in their action than derris. Both derris and pyrethrum are relatively non-poisonous to man and higher animals and may be used freely on garden crops. All dusts should be applied during periods of calm weather and are usually more effective when used in the evening or in the early morning. When a power or traction duster is employed, the dust should be discharged under a trail sheet of cotton or light-weight canvas, twenty to twenty-five feet long. This holds the dust cloud and allows the dust to reach all parts of the plants.

Keeping fields and gardens free of weeds at the time the moths are laying their eggs may prevent patches of infestation which might spread throughout the field.

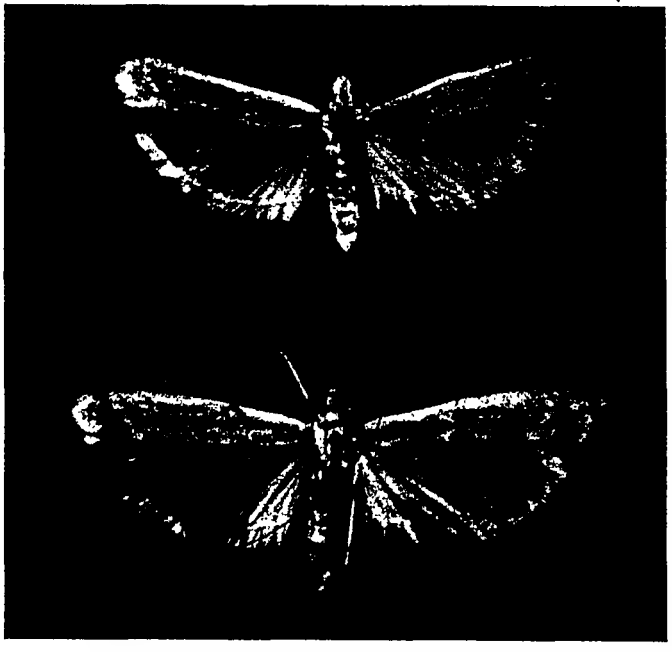


FIGURE 28—Sunflower moth. Adults. About three times natural size.
—*Photo R. D. Bird.*

FIGURE 29—Sunflower moth. Larvae in sunflower head. About twice natural size.
—*Photo R. D. Bird.*

SUNFLOWER MOTH[1]

Whenever the acreage of a new crop is increased we should be on the lookout for possible pests. The sunflower moth was found on wild sunflowers in Manitoba as long ago as 1919 and caused severe damage to small plantings in the Red River Valley in 1936 and again in 1940 and 1941. With the great increase in sunflower acreage we must watch for any occurrence of this potentially serious pest.

Recognition and Characteristic Injury

The injury is more readily seen than the insect. After the seed has set, discoloured areas will be noticed among the seeds. Masses of debris are held together with loose silken webbing and on close examination small caterpillars will be found among the partly devoured seeds.

Adults are small grey moths which fly at dusk.

Eggs are laid in the flowers.

Larvae are about three-eighths of an inch long when fully grown and have broad black stripes running the length of the body.

[1] *Homoeosoma electellum* (Hlst.), Family Pyralidae (Pyralididae), Order Lepidoptera.

Damage and Distribution

The sunflower moth appears periodically. In bad years, it has destroyed up to eighty per cent of the seeds. It is distributed throughout Manitoba, eastern Saskatchewan and possibly farther west.

Life History

The life history is not fully known. Moths appear in late July or early August when the sunflowers begin to bloom. Eggs are laid among the florets and larvae appear when the seeds commence to set and may be found throughout the autumn.

Control

Control appears to centre around the development of a variety of sunflower whose seeds are able to resist penetration by the caterpillar. Experiments are under way but have not yet been completed. Sunrise which has a high oil content, appears to be more resistant than some strains of the variety Mennonite.

DIPTERA

WHEAT STEM MAGGOT[1]

Recognition and Characteristic Injury

WHEAT stems infested with wheat stem maggot are recognized easily after the crop is in head and just before it begins to ripen. The maggot severs the soft part of the stem just above the top joint, or node, and that part of the stem including the head ripens and turns straw-coloured while the lower part of the infested stem and the leaves remain green (Plate II, lower right). Uninfested stems throughout the field are still green at this time. If the head of an infested stem is pulled with the hand, the head and that portion of the stem above the top joint will pull out readily and the lower soft part of the stem just above the joint will show where it has been severed by the maggot. The infested stem, which does not fall, is cut off just above the top joint or node before the head comes into flower or before the stamens shed their pollen. In consequence, no kernels form in heads borne on infested stems. This is indicated when such a head is ground up between the hands. No trace of kernels will be found. Usually the infested stems bearing prematurely ripened heads are a

[1] *Meromyza americana* Fitch, Family Oscinidae, Order Diptera.

few inches shorter than the normal ones and may be seen scattered throughout the field.

Damage and Geographic Distribution

Damage done to the wheat crop varies greatly from year to year, from field to field and with respect to varieties. As revealed by an examination of many varieties of bread and durum wheats at Winnipeg over a period of six years, some varieties are less susceptible to infestation than others. Records indicate that the wheat stem maggot is found over a wide area in both Manitoba and Saskatchewan where damage ranges from a trace to as high as twenty per cent of the crop in some local fields in years when infestation is worst. For the most part it is of minor importance although on occasion destructive infestations have occurred in some fields. Typical injury to crested wheat grass, western rye grass and meadow fescue indicates that this insect attacks these plants in Western Canada, but few if any mature live maggots have been found in these grasses. It is probable that although the flies may lay their eggs on these grasses the maggots cannot attain maturity in them.

Life History

Adults of the wheat stem maggot, which are small two-winged flies, appear in the field around the middle of June. The flies are yellowish white, are about one-fifth of an inch long and have three longitudinal black stripes on the thorax and abdomen. They have conspicuous green eyes. The female lays small, plainly visible, snow white eggs, one in each location, on the leaves of the plants. In Manitoba most of the eggs have been found near the ground. Relatively few eggs have been seen high up on the plants. The eggs hatch in approximately one week. It is believed that the maggots which hatch from eggs laid on the top leaves move between the leaf sheath and the stem to a point just above the top node where they sever the stem. The maggots require about three weeks to develop. Upon reaching maturity the maggot moves upward between the leaf sheath and the stem to about one or one and one-half inches below the place where the leaf leaves the stem. There it becomes a pupa. The pupal stage, which includes the prepupal form, lasts for about seventeen or eighteen days in summer. Records of adult emergence show that they appear largely during the first half of August. Where these adults lay their eggs for a second brood of maggots is not known for Western Canada. Elsewhere they lay on grasses and volunteer grain. The eggs hatch

shortly thereafter, and the insect over-winters in the larval stage.

CONTROL

Wheat should be sowed as early as possible in the spring as there is some indication that this results in decreased infestation. A variety of wheat that shows a relatively small percentage of infestation and one that is suitable for the area should be grown. Crop rotation should be practised as most other crops are not infested.

FIGURE 30—Hessian fly. Flaxseed stage on wheat. About three times natural size.
—*Photo Dominion Department of Agriculture.*

HESSIAN FLY[1]

The hessian fly, a serious pest of wheat in the central United States, occurs in the more humid wheat-growing areas of the Prairie Provinces of Canada. The insect is not abundant and it is quite probable that hessian fly will never be a serious pest of wheat in this climate. Farmers who have come to the prairies from states where this insect is a serious pest, and those who have either seen the insect or read about it have expressed considerable concern at finding the 'flaxseed' puparia in their crops. While it is unwise to ignore a pest which can be as serious as the hessian fly has been farther south, there is little cause for concern, as the insect has not shown any inclination toward increasing in numbers over the last several years.

[1] *Phytophaga destructor* (Say), Family Cecidomyiidae, Order Diptera.

FIGURE 31—Wheat stem sawfly. Adult female. About four times natural size.
—*Photo R. D. Bird.*

HYMENOPTERA

WHEAT STEM SAWFLY[1]

THE wheat stem sawfly is a native of the Great Plains area of Canada and the United States. It originally survived in the tall native grasses, but when wheat was introduced it readily turned its attention to this crop. The gradual spread and increase has continued to the point where it now ranks as one of the major hazards to wheat production in the hard spring wheat belt.

Life History

The adult wheat stem sawfly is a narrow-bodied, wasp-like insect about one-half of an inch long. Its body is black with yellow bands. During the latter part of June and early July it can be found flying among the plants in the margins of wheat fields. The egg is laid inside the stem of the wheat plant. From this egg a small grub hatches which completely tunnels the stem. As the plant ripens, the grub re-

[1]*Cephus cinctus* Nort., Family Cephidae, Order Hymenoptera.

tires to the bottom of the stem, girdles it from the inside at ground level and remains below the cut, in the stub, which it has lined with a silken cocoon and plugged at the upper end. The winter is spent in the stub, and toward the latter part of May or early June the grub transforms into a pupa, from which the adult emerges about the middle of June.

How to Recognize the Presence of Sawfly

The most obvious means of recognizing sawfly infestations in a field is the presence of fallen stems at harvest time (Plate II, upper right). The stems are cut off just at or about ground level. The upper part of the stem is filled with a sawdust-like deposit, while the stub left in the ground will contain an active grub about one-half of an inch long. Any time after the middle of July the degree of infestation in a wheat field can be determined by splitting the standing stems and examining them for the sawdust-like deposit and the hollow nodes.

Effect of Farming Practices on Wheat Stem Sawfly

Any type of farming practice or rotation in which wheat is seeded on land containing infested stubble, or adjoining such land, tends to increase the abundance of the wheat stem sawfly. Infestations in large field units, which are summerfallowed in alternate years, are usually found to be confined to the margins. Strip farming, on the other hand, with many margins exposed to invasion from adjacent summerfallow, greatly intensifies the infestation.

The increase in the use of the combined harvester-thresher has tended to increased losses from this insect. As the insect cuts the stem just before the wheat is ready to be harvested, the practice of letting the crop stand until it is thoroughly ripe so that it can be combined insures all of the infested stems being cut by the insect. This means that unless the crop is very heavy and the infestation light the majority of the cut stems will fall to the ground, where they cannot be recovered by ordinary harvesting machinery.

Control

A most important element in the effective control of wheat stem sawfly is the recognition of the presence of the insect and its potential capacity to destroy crops. If steps are taken to reduce its numbers when infestations are small, very severe losses can be avoided. Farmers are well advised to acquaint themselves with the type of damage caused so that when the first signs of the insect are found in their fields, control measures may be undertaken. In order to establish success-

ful control in any community there must be wholehearted co-operation on the part of everyone. Careful planning is essential in order to obtain the best results. Wheat farmers throughout the infested area should incorporate control of the wheat stem sawfly as a part of their regular farming practices.

Trap Crops

The adult insect seldom flies farther from the point of emergence than is necessary to find suitable plants in which to lay its eggs. This is why the margins of cropped land nearest to the point of emergence

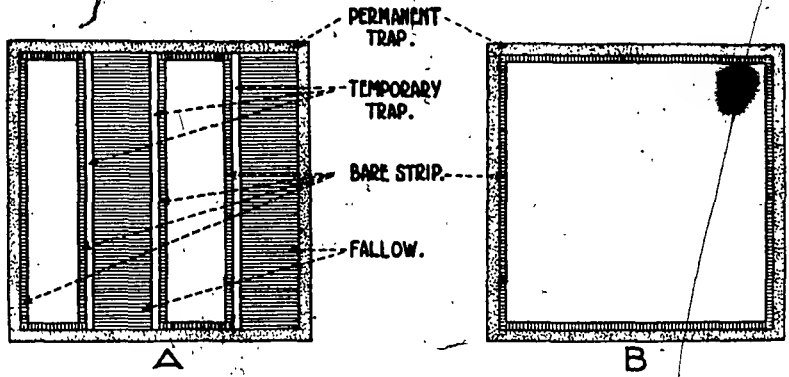


FIGURE 32—Diagram showing ground plan of trapping methods: (A) arrangement of the protective traps on a stripped farm; (B) best method of guarding a large field from attack by sawfly.
—*Courtesy Dominion Department of Agriculture.*

are more heavily infested than the middle of the fields. This habit of the insect has given rise to the practice of using the field margins as a trap and cutting this growth for hay to destroy the eggs and grubs in the stems. Trap crops have been found to be very useful in the control of wheat stem sawfly. A trap crop consists of a strip of crop so located that the insects moving from an infested part of a field to an uninfested portion must pass through the trap in order to reach the main crop. The accompanying diagram (Figure 32) illustrates the relative position of the trap and the crop.

Recent experiments have shown that if a strip of land from ten to twenty feet wide is kept free of vegetation between the trap crop and the main crop, the adult sawflies moving about among the stems hesitate to fly out over the bare ground. This permits the use of a narrower trap crop and insures a greater number of eggs being laid in it. In Figure 32, the protective border trap is a permanent trap of

brome grass. The temporary traps consist of early sown grain, and the white areas represent the crop. In areas where brome cannot be established or where the growth of brome is very poor, the border should be a trap of early seeded wheat.

Permanent Traps

A permanent trap for wheat stem sawfly control is established by planting brome grass in the headlands or road allowances adjoining the wheat fields. The establishment of this trap should, as far as possible, be undertaken on a community-wide scale, even where temporary trap crops are also used, and should be considered as an essential part of any far reaching control program.

Temporary Traps

A temporary trap crop is one which must be seeded each year and must be some plant which is readily attacked by the wheat stem sawfly. When used with a bare strip, this trap need be no more than twelve to twenty feet wide (See Figure 33). Wheat has been found to be the most satisfactory temporary trap. IT IS IMPORTANT THAT THE TRAP BE PLANTED ON SUMMERFALLOW, to allow for a maximum growing period. The main crop should be planted TEN DAYS TO TWO WEEKS after the seeding of the trap. In severely infested fields additional strips of wheat seeded into the stubble will catch and destroy sawflies before they leave the fields in which they over-wintered. These traps are supplementary to the fallow bare-strip traps. In some

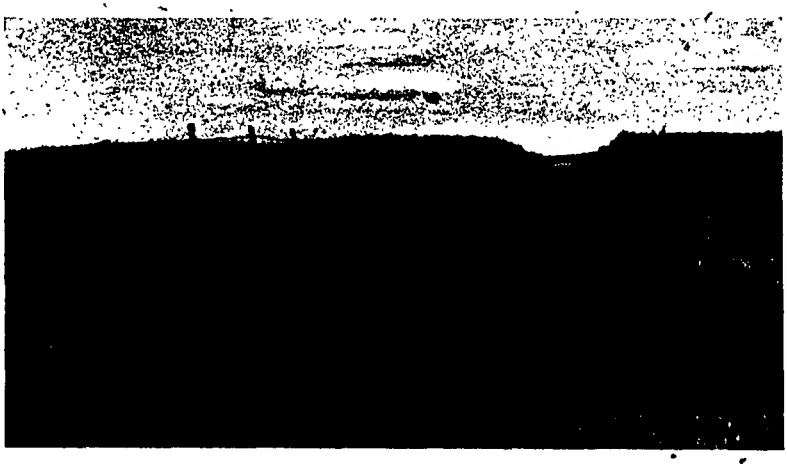


FIGURE 33—A bare-strip trap in use at Rockyford, Alberta, in 1940.
—*Photo Dominion Department of Agriculture.*

areas spring rye has been found to be an exceptionally satisfactory trap. The chief advantage in using spring rye lies in the fact that it may be seeded at the same time as the wheat or even two or three days after the seeding of the crop. TEMPORARY TRAP CROPS OF WHEAT AND SPRING RYE MUST BE CUT FOR HAY ABOUT THE MIDDLE OF JULY OR DESTROYED BY CULTIVATION. Oats and barley are not satisfactory trap crops.

Resistant Crops

Oats, barley and flax can, for all practical purposes be considered as immune. Occasionally barley is severely damaged but this is not general. Durum wheat is less severely damaged than hard spring wheat.

Resistant crops should be used to eliminate sawfly from the more severely infested farms or parts of farms.

Delayed Seeding of Wheat

Late seeded wheat is less seriously infested than early seeded wheat. Wheat seeded about May 24th is usually free from serious infestation. Thus it is possible to grow wheat in severely infested fields providing it can be delayed so that the stems are not sufficiently advanced to be attractive to the sawfly during the egg-laying period.

Tillage

In areas where the mouldboard plough is extensively used, good control can frequently be secured by ploughing down infested stubble to a depth of six inches or more, followed by packing, any time between harvest and June 1st of the following year. Shallow cultivation with a one-way disk, duckfoot cultivator, or blade weeder has been found to be quite effective in destroying over-wintering grubs in the stubs. The implement must be set to work deeply enough to pass just below the crown of the plants. The effectiveness of surface tillage depends upon the numbers of infested stubs exposed on the soil surface and thereby subjected to hot weather. The more heavily infested margins of fields should be surface-tilled as soon after harvest as possible. Spring tillage must be done as early in the season as possible so as to allow for a maximum period of exposure.

Strictly speaking, summerfallow is not a control practice but it does serve a useful purpose in driving sawfly out of a field. However, if tillage operations are carried on in the fall or early spring, systematically, either to expose the stubs or bury them deeply, considerable reduction in numbers occurs. Every effort should be made to prevent

the migration of sawflies into adjoining fields during the summerfallow year. This can be accomplished by leaving borders of volunteer wheat to serve as a trap or by planting trap crops on the borders of infested stubble.

Stubble burning is not effective.

Strip Farming

Since this relatively recent type of farming is now being used extensively throughout the prairies, a special warning should be given concerning the danger farmers are likely to encounter. Relatively light infestations of from one to three per cent can increase so rapidly as to infest a field in three years. Hence, at the first signs of sawfly damage in a stripped field all cropped strips adjacent to infested stubble should be protected with bare strip traps. If early action is taken, disastrous losses can be avoided completely. If, on the other hand, these infestations are allowed to increase to serious proportions, it will require several years of systematic trapping to bring the sawfly under control.

In the more severely infested areas where strips are so narrow that trapping is uneconomical, it is recommended that the cropping system be changed so as to provide for a large coarse grain or flax acreage. Any wheat seeding must be delayed until May 20th or later.

Harvesting Infested Crops

The most severe loss from the wheat stem sawfly is associated with the fact that the stems fall to the ground and are missed by the harvesting machine. In many instances the fallen grain is a complete loss because rain during harvest beats it to the ground where it cannot be recovered. Farmers throughout the infested area are advised to examine their fields during the latter part of July to determine the extent of the infestation. If twenty per cent or more of the stems are found to be infested, plans should be made immediately to commence harvesting operations on the infested portions of the field while the grain is slightly on the green side. This will eliminate the necessity of using special pick-up attachments and the possible complete loss through sprouting in wet weather.

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